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THE THIRST THAT IS NEVER SATISFIED.

It might not be a hard task to show that the story of Tantalus is a veritable symbol of the state of man in his thirst for knowledge. He is immersed in sources of wisdom, yet how little does he taste; a perpetual desire to add to his little stock and store suffices to keep him ever active, never discouraged by the small results of so much longing. Compare our modern science with the attainments of antiquity, and it will be found that we have not gained much. When Bacon grounded research on the inductive method, the old barricades to progress disappeared, and wonderful indeed have been the results in detail; but in the discovery of great principles, who can aver that modern science has accomplished much? The cycles of the moon and the laws of gravitation were truthfully taught in the mystic caves of India three thousand years ago. The judicial astrology of the Chaldean priests recognized many of the truths in an ideal and empirical form, which our modern astronomers have only recently verified for themselves. Pythagoras, who first propounded the term "philosopher," had as clear an idea of planetary motions, five hundred years before the Christian era, as Copernicus attained to in his revival of astronomy, or Newton in his glorious confirmation of it, by the introduction of the law of gravitation. Fire and water were held to be the prime agents in the formation of the world ages before the word geology was coined as a designation, and Dalton's atomic theory had its exponents in what we sometimes call the poetic age—poetic because removed from us by the lapse of dim centuries. Much of our supposed progress has been a movement in a circle, and in the future man will still pursue the same mental revolution, like a star set in an orbit, obedient to an initial impulse and an attraction towards a centre. The inquirer knows not how vast is the system in which his particular object of research is but an element of detail. It is well for him that he looks straight forward at his own chosen class of facts, else its infinitesimal proportions, as compared with the whole, would dispirit him. Like Tantalus, he would deem it a divine happiness to taste but one of the fruits that float almost within reach of his eager lips, all unconscious of the hidden truth that he is seeking and searching for something more, for something which lies beyond the prize, for something higher, greater, and more enduring. What is the meaning of this inquiry after second causes, that gives life to astronomy, geology, chemistry, botany, physiology, and the rest of

the sciences? It is surely not a desire to attain to second causes for their own sakes, and to rest in them as all-sufficient to slake the thirst of an immortal being. It is to attain to the First Cause that the philosopher labours, but a benignant fate enshrouds from him the impenetrable mystery, that he may pursue his way undaunted by the final impossibility.

It is to find out God for which we elaborate microscopes of greater and greater power, as if we hoped to pierce to the very core of life, and read its minutest lessons of inscrutable wisdom; it is to find out God that we pierce the heavens, probe the deeps, ask questions of the wayside flower, and arrest the honey-bee while singing its work-day song upon the wing. We put the odours of a honeysuckle into the crucible; pierce a fossil bone with shafts of lightning; reduce adamant to impalpable powder; call the stars towards us until we almost touch them; make the orb of day a slave to paint pictures, and confess to the blemishes on his own face; consolidate in one atmosphere all the climates of the earth; creep into the microscopic cell of a living vegetable structure, in order that we may feel the moving of its lymph-like blood, and make the ultimate globule of animal life pause on its way to its destination in order to tell its story;—all to get beyond the things palpable to that which eye hath not seen nor ear heard. We would

> "Stretch lame hands of faith, and grope
> To what we feel is Lord of all;"

but we get only shadows of His wondrous attributes, and it is not in the province of science to attain to His personality. Why do we thus fail, and find ourselves like stray leaves upon a tidal river, ever and anon brought back to the point from whence with so much hope we started? It is because we trust to the intellect to reveal that which is susceptible only by the moral faculties. We use but one part of the strength with which we have been blessed by the Author of our being, and attempt to acquire by logic and experiment that which is alone the reward of faith.

As with the attainment of results, so with the enjoyment by the way. He only knows the joys that science has in store for those who woo her, who approaches her shrine in a spirit of devotion to the Power under whom she sits a tutelary genius. Out of that Faith springs a Hope sufficient to sustain the votary in the search on which he is bent, even though, like Tantalus, he may obtain for the present nothing to satisfy his thirst. The little drops that bubble to the lips, and give a foretaste of the entire wisdom that shall be revealed, are indeed precious; and how they beget a yearning for the time when, between the strife and the prize, there shall be only such a gulf fixed as it will be a joy to pass over, and knowledge will culminate in a perfection of which at present we have but faint glimpses. Through Faith we are promised moral perfection, but there is no promise that the mind shall ever be satiated with the fruits of intellectual inquiry.

"Canst thou by searching find out God? Canst thou find out the Almighty unto perfection?" Not here, perhaps, nor in the life to come. In all the relations of love we shall acquire full and perfect knowledge, and drink from the Fountain-head of eternal truth and goodness; but the mind will continue its endless round of questions, and as the angels desire to look into the mysteries of man's relation to the Godhead, so will man, in his beatified completeness, still desire to look into the relations between the Godhead and the material universe, which forms the boundless circumference of that Effluent Centre. It is our destiny, as elements in a system of incessant activities, to pursue, with restless energies, the inquiries we have chosen for our delight. It will be a cold task if we have no faith, no trust, no hope beyond the petty item of a fact, or the indefinable boundary

of a law. "There is neither rest nor pause, but ever change and motion, a curse still cleaving to standing still." Goethe was right; but he might have added, that the curse attends also every action that is not begun and ended in full and happy recognition of the End of all things, which is God. From Him they sprang, and to Him they shall return; and while the cycle is in process of completion, the proper song of Science will be, "Glory to God in the highest; peace on earth; good-will to man." H.

ANCIENT AND MODERN HYDRÆ.

THE word Hydra is derived from ὕδωρ (*water*); but, in classical literature, it is the name of a celebrated monster which infested the neighbourhood of the Lake Lerna in Peloponnesus. The fable of this mythological monster has so great an analogy to the history of the little animal which we shall describe, as to be worth giving a short account of it, and then the reader must form his own opinion as to how far he thinks the Greeks were acquainted with the history of this or some other animal of like properties, and from it constructed the fable.

The Hydra, or sea-serpent, had, according to Diodorus, a hundred heads, fifty according to Simonides, and nine according to the more recent opinions of Apollodorus, Hyginus, etc. As soon as one of these heads was cut off, two immediately grew up in its place, if the wound was not stopped by fire. It was one of the labours of Hercules to destroy this dreadful monster, and he attacked it with his arrows, and soon after came to a close engagement, and, by means of his heavy club, he destroyed the heads of his enemy. But this was productive of no advantage, for as soon as one head was beaten to pieces by the club, immediately two sprang up, so that he commanded his friend Iolas to burn, with a hot iron, the root of the head which he had crushed to pieces. This succeeded. While Hercules was destroying the Hydra, Juno, jealous of his glory, sent a sea-crab to bite his foot. This new enemy was soon despatched, and Juno, unable to succeed in her attempts to lessen the fame of Hercules, placed the crab amongst the constellations, where it is now called the Cancer. The conqueror dipped his arrows in the gall of the Hydra, and from that circumstance all the wounds which he gave proved incurable and mortal.

Such is the history of the name now applied to a genus of minute gelatinous animals, distinguished from other tribes of the class Polyfera, to which it belongs, by being free, naked, furnished internally with a simple stomachal cavity, which is provided at its entrance with highly contractile tentacula, without traces of viscera, and reproduced by external gemma.

No one need be alarmed at our modern monster, for any one, during the summer months, may find diversion and instruction in observing its habits and structure, by collecting, from our stagnant pools and ditches, some of the common duckweed (*Lemna minor*), or other small aquatic plants, and placing them in a glass vessel with some clear water; allowing them to remain undisturbed a few hours, and then, no doubt, numbers of the Hydra will be seen adhering to the side of the vessel and on the roots of the plants, but so small as to require the aid of a magnifying power to watch them (Fig. 1). The *H. viridis* has much the appearance of a bit of green sewing silk, is about the sixth of an inch long, and attaches itself by one extremity, having its

opposite end apparently twisted. Upon further examination it will be seen that its body is formed like a little bag, open at one end; this is its mouth, and is surrounded with seven very delicate thread-like arms (*tentacula*), and that the other extremity is furnished

FIG. 1.—*Hydra viridis* on roots of *Lemna minor*, slightly magnified.

with a minute disk-like sucker, by which it is enabled to attach itself to the roots of the plants, etc. Examine it carefully, and I think you will say that it looks like a gelatinous thread, in which are a few greenish granular particles; disturb it, and it shrinks into a minute jelly-like spot, but expands again when left undisturbed, so that it has the power of contraction and extension. Observe it still further, and you will see that it has the power of locomotion; attached by its sucker, it extends its body to its full length, and with its arms takes firm hold with the other; it then relaxes its sucker and advances it towards its head, and again fixes itself; and thus, by a repetition of these movements, it makes progress. It is slow, certainly, but consider the size of the animal, and, further, what is its mode of sustenance. It has been observed, however, that it has another and very remarkable mode of diverting itself; that is, by rowing about in a very ingenious and wonderful manner. To accomplish this, the little creature first moves itself to the surface of the water in the manner above described; it there protrudes its little sucker above the surface, and dilates it into a hollow cone-like cavity, thus forming a miniature boat, and by this curious contrivance it is enabled to float its body, and with the aid of its arms, which it uses as oars, it is enabled to row itself about in any direction it pleases; but, if it become alarmed and is desirious of getting out of danger, it contracts up its little boat, and, from its body being specifically heavier than water, it sinks to the bottom. Observe, also, the effect which light has upon it. On the side of the vessel turned from the light you will not find them; but turn it round, and they are congregated on that side. Leave it for a few hours, and then they will have changed their position to the other side again. showing that they are attracted by the solar rays; but how they act upon the little animal we know not, as hitherto no organs of vision, or even a nervous system, has been detected.

Let us now inquire further into its mode of living, and we shall be astonished at so minute a gelatinous-looking creature being endued with such powers as it has. It is carnivorous, and most voracious in its habits, and is gifted with such terrible powers of destruction, as to capture and devour the lava of insects, etc., larger, stronger, and more active than itself. It does not, however, wander about for its prey, but lays wait for it. Having firmly fixed itself by its sucker, it elongates its body, and spreads out its arms in different directions, and when any wandering animal inpinges upon its arms, it is immediately arrested, and becomes motionless as if benumbed. And this, be it observed, is the more remarkable, as it was not struck, but only touched, by the arms of the

Hydra as it was moving along in its own course. What power the arms of the Hydra possess it is difficult to conjecture; its effects are like the sudden shock of electricity, for the animal, under the influence of its potent shock, seems motionless and sinks to die, or only after the lapse of some time recovers itself. When the prey is thus become motionless, the Hydra slowly contracts its arms around it, and gradually brings it to its mouth, and then engulphs it in its capacious stomach.

We may now observe what takes place upon the prey that is swallowed into the distended stomach, for the body of the Hydra is so thin and pellucid that, with the aid of magnifying glasses, we are enabled to see the process; nor have we to wait long, for soon the swallowed animal loses its form, and becomes a confused mass; all its digestible parts are then soon dissolved, and that which is hard and indigestible, such as its shell, etc., is at length expelled from the stomach through the opening by which it was admitted. It occurred to Trembley (whose observations upon the Hydra are the earliest and best upon record), that from the transparency of the body of the Hydra he might ascertain the manner in which the digested particles became appropriated to the sustenance of the animal. To accomplish this, he fed the Hydra with the red larva of some insect, and the result was, that it is through the medium of the green granules floating in the semi-fluid transparent substance of the Hydra, that the diffusion of the coloured particles was accomplished, and that the granules themselves became of the same colour as the food, but that the gelatinous matter remained colourless.

Trembley also remarked that the digestive power of the Hydra had no influence on the tissues of its own body; for he observed that some of the species occasionally swallowed their own arms together with their food, and these remained during the process of the digestion of the animal which it had swallowed, without being injured. On one occasion, the same author says that he observed the extraordinary occurrence of two Hydra having hold of the same prey, and that they contended for the possession of it, and that the conquest was terminated by one swallowing the object of dispute, and also its rival. But imagine what was the observer's astonishment when he afterwards saw the swallowed Hydra, together with the refuse of the digested meal, ejected, and that the Hydra, after its capture and imprisonment in such a perilous place, was apparently none the worse!

Wonderful as these facts are regarding the nutriment of the Hydra, they are not more so than the manner in which the species are multiplied, or its lost parts restored. Trembley cut a body transversely into two, and others into several portions, and he found that each part, in process of time, became furnished with arms at one extremity, and with a sucker at the other, and acquired all the powers and characters of a perfect individual; so that in this way it is like a plant propagated by cuttings. The usual manner, however, in which it multiplies its species appears to be by gemmation, that is, it has the power of sending forth, from different parts of its body, a little bud or gemma, which at first has the appearance of a shapeless excrescence, which in a short time becomes developed into a body similar to its parent, having arms, a mouth, and stomach. Until, however, it is fully formed and perfected in all its parts, it remains attached to its parent by a short pedicel, and enjoys, by this means, an entire communication of food, by that of one freely passing into the other. Sometimes this offsprout puts out another bud, even while it is attached to its parent, so that three generations may be united together. Trembley even found that by snipping the side of an adult polyp with the points of a fine pair of scissors, that a bud was soon developed from the wounded part, and that by making

this experiment repeatedly, both upon the parent and its progeny, he obtained as many as seventeen all connected with each other.

Let us now examine more carefully into the structure of these little animals, which are endowed with such wonderful powers, in order that we may better understand its economy and habits; and a few remarks and illustrations from the investigations of Corda will be perused with interest. This author has examined most carefully the *Hydra fusca* (Fig. 2), and he considers the arms (*tentacules*) to be long, pellucid, extremely delicate tubes, of a membranous structure, and that they contain a semi-fluid albuminous substance (Fig. 3), which in certain definite parts swells into wart-like knots of a denser substance (Fig. 3, *b*), and that these are arranged in a spiral manner, into which are attached numerous organs of touch, and also instruments by which it holds its prey (Fig. 3, *c*). Within the tube, and running beneath these knots, are four longi-

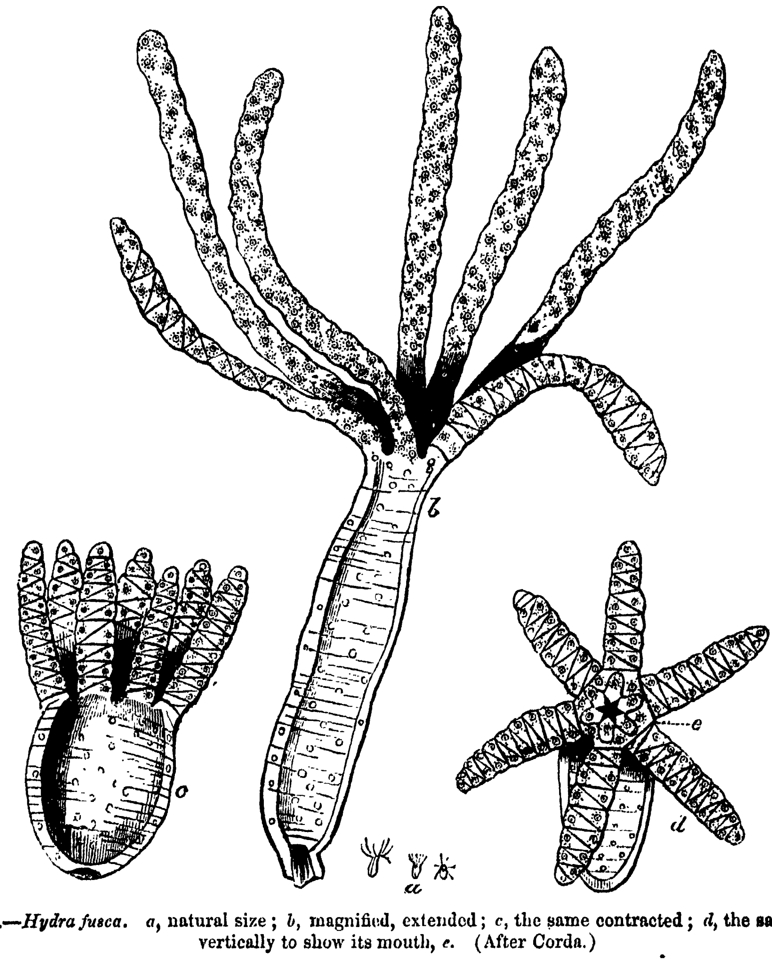


FIG. 2.—*Hydra fusca*. *a*, natural size; *b*, magnified, extended; *c*, the same contracted; *d*, the same seen vertically to show its mouth, *e*. (After Corda.)

tudinal bands of muscular fibre, of a yellowish colour (Fig. 3, *e*). With these fibres it is thought that the animal has the power of extending the arms. These muscular fibres are united to each other by transverse muscles (Fig. 3, *f*) of the same colour, and Corda considers that by these the animal is enabled to contract its arms, and fold them up like a fan (Fig. 2, *c* and *a*).

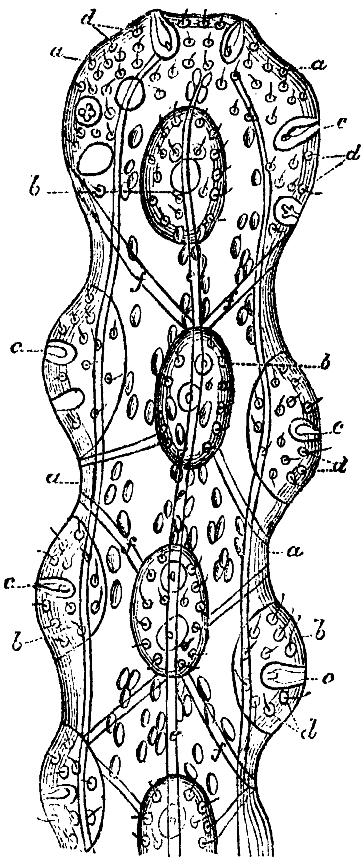


FIG. 3.—End of Arm (tentacule), highly magnified. *a*, investing membrane; *b*, wart-like knobs; *c*, prehensile darts; *d*, organs of touch; *e*, longitudinal, and *f*, transverse, muscular bands. (After Corda.)

In the wart-like knobs of the arms are, according to Corda, the organs of touch or sensibility. Each of these is formed of a delicate little sac, which incloses another with a minute cavity in its centre (Fig. 4). Every one of these curiously-constructed bodies terminates in a very delicate hair-like process,* and form the supposed organs of touch. Amongst each group of these organs

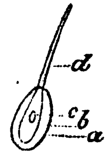


FIG. 4.—Organ of Touch, highly magnified. (After Corda.) *a*, first, and *b*, second sac; *c*, minute cavity; *d*, terminal filament.

are others, but less numerous, and differently constructed. Corda named these darts, and considers them the organs by which the animal hold its prey. This organ is formed of a little, pellucid, oval sac (Fig. 5), embedded in the substance of the knob, and has a small

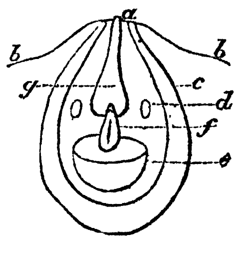


FIG. 5.—Prehensile Apparatus, highly magnified. (After Corda.) *a*, aperture; *b*, epidermis of tentacule; *c*, first sac; *d*, second sac; *e*, saucer-like body (*vesica*); *f*, oval base (*hastifer*); *g*, dart.

opening at the apex (Fig. 5, *a*). At the bottom of this sac is a saucer-shaped body (Fig. 5, *e*), upon which is placed a solid oval granule, and this supports a long, sharp-pointed spiculum (*sagitta*), composed of calcareous matter, and is capable of being pushed out and in through the aperture (Fig. 5, *a*), probably by the in-

flation or contraction of the little bladder, to which the oval base of the dart (*hastifer*), is attached.

When the Hydra is waiting for its prey, the darts are all protruded, so that its arms become formidable weapons, furnished with their numerous spikes. But, more than this,

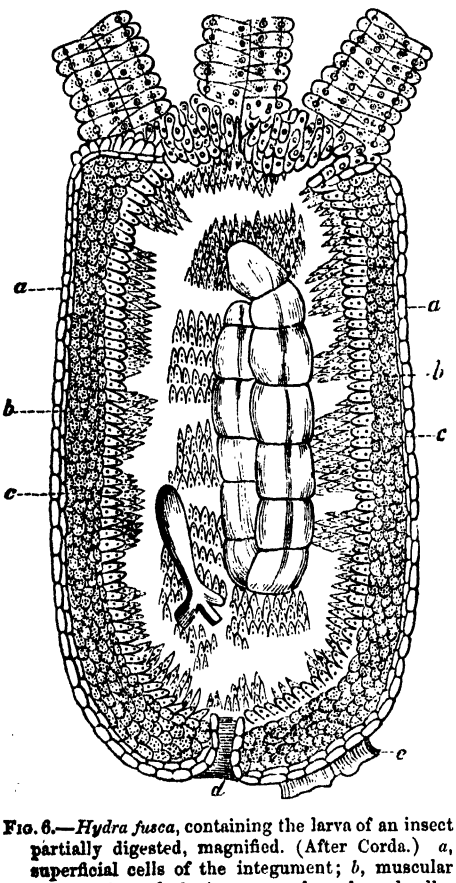


Fig. 6.—*Hydra fusca*, containing the larva of an insect partially digested, magnified. (After Corda.) *a*, superficial cells of the integument; *b*, muscular stratum, formed of minute granular coloured cells; *c*, villous tunic; *d*, anus; *e*, sucker.

these spikes appear to be poisonous also; for any unfortunate animal once touched by the Hydra immediately becomes benumbed, and soon dies, but slowly recovers from its effects.

The mouth of the Hydra is at the base of the arms (Fig. 2, *e*), and is furnished with lips capable both of inflection and protrusion. Their structure is similar to that of the arms, but they appear to be endowed with extraordinary muscular force, considering the size of the animal.

The body of the Hydra is not furnished with either darts or organs of touch, but, according to Corda, is covered externally with a membrane formed of two layers (Fig. 6, *a*), and that between it and the alimentary canal is a muscular layer, composed of dense coloured cells, having the appearance of being filled with minute granules (Fig. 6, *b*).

The innermost layer, which lines the whole alimentary canal from the lips to the arms, is divided at intervals into folds forming numerous compartments (Fig. 6, *c*). The villi of which this layer is composed is closely connected with the muscular layer. They are of a cylindrical shape, and apparently of two kinds, some of them having a minute opening at the apex, others closed. The use of the perforated villi appears to be that of conveying the nutritive matter of the ingested food into the interior and nourishment of the animal.

Such is the history of the modern Hydra, and though so wonderful, it is not more so than that of hundreds of other minute animals which inhabit the same water that it does; nay, every drop in our glass jar is crowded with them, as revealed by the microscope, so that the student of Nature's works may thus find abundant objects for his research, and each he will find perfect in itself; and in every step he takes in the acquirement of such knowledge he will be ready to cry out with the royal Psalmist, and say, "O Lord, how manifold are thy works! in wisdom hast thou made them all: the earth is full of thy riches."

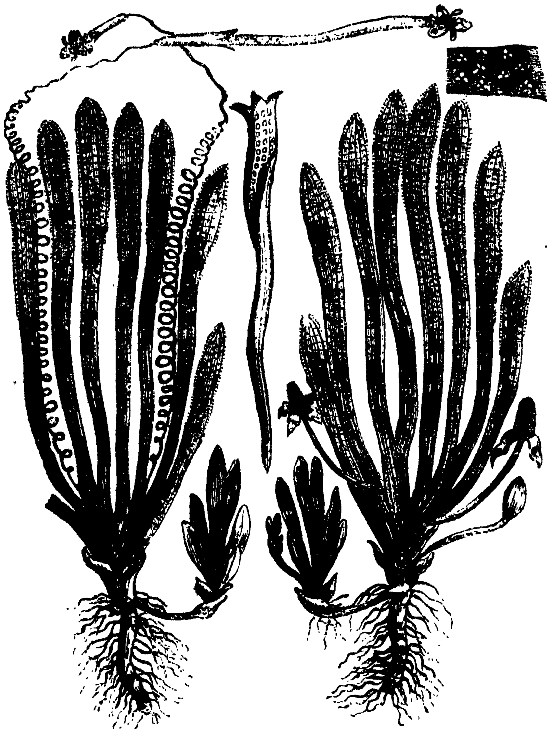
RICHARD DEAKIN, M.D.

VALLISNERIA SPIRALIS, AND THE SEAT OF LIFE MADE MANIFEST.

THIS well-known and beautiful aquarium plant has a history of its own, apart altogether in its intrinsic interest from the plants with which it is botanically and practically associated. It is, indeed, one of the wonders of the vegetable kingdom, both as to its mode of growth and physiological constitution, and one of the most prized of subjects for the microscope within the range of the study of organic forms. Many who grow this plant in tanks and jars suppose themselves possessed of all the secrets of its constitution; for, having it constantly before them, they can, they suppose, observe its peculiarities under every variety of circumstance, and submit its cells to the revealing eye of the microscope, in order to observe that most beautiful and wondrous of all microscopic panoramas, popularly known as the "circulation of the sap." In devoting a short space to an account of this plant, many aquarians and noviciates in the microscope will probably discover that they had not attained to so complete a knowledge as was possible, under the several advantages within their reach, and it will also be found that for the study of one department of the subject we are still in a disadvantageous position, having, in fact, only half the species in our possession.

Vallisneria takes its generic name from A. Vallisneri, an Italian naturalist, who is thus honoured by a rule of technology common in natural history, but whose name has no connection with the plant, beyond being kept in remembrance by it. The specific term *spiralis* is appropriately descriptive, for one portion of the fructification, as we shall presently see, is borne on spiral stems. The plant was introduced into this country in 1818, and from that date to the present has been prized as a necessary part of the furniture of tanks in hothouses, and for grouping with water-lilies in the basins of conservatories, a use to which it is admirably put at the Crystal Palace, where it may be seen forming fine tufts of grass-like foliage in the basin at the cool end of the nave, in company with *Nympheas, Limnocharis Humboldtii, Nelumbium speciosum*, and the pretty *Riccia fluitans*, on which notes have been made in our "Microscopic Observer." This water-plant introduces us to a family with which every aquarian ought to be well acquainted. In the natural system, *Vallisneria spiralis* is a member of the 225th order, *Hydrocharidaceæ*, or frogbits, and its botanical kindred are among the most interesting of all the aquatic plants that are introduced to tanks. The frogbit, *Hydrocharis morsus ranæ*, which gives its name to the order, is a floating plant with pretty white flowers, admirably adapted for covering the entire surface of an aquarium which enjoys full exposure to vertical light. The water-soldier, *Stratiotes aloides*, is a remarkably bold and showy plant, and *Anacharis alsinastrum*, the water-thyme, is too well-known to need more than a mention, in order to connect it with the group. Each of these, and a few others that need not now be specified, have their several points of botanical and physiological interest, and it may be well some day to group them together for a separate study. Suffice it now that the *Hydrocharis* tribe includes these, with the *Vallisneria*, as having certain peculiarities in common, and one of these peculiarities is, that the flowers are generally unisexual. In the majority of ornamental flowering plants, the male organs (stamens) and female organs (pistils) are inclosed in one and the same corolla, the flowers are therefore bisexual, and fertilization takes place by the diffusion of pollen from the stamens upon the pistils,

and the flowers give place to seeds. In *Hydrocharidaceæ*, the male organs, or male flowers, are borne on separate stems or separate plants to the female organs or female flowers, and hence each separate flower is of one sex only, and Nature calls us to behold



Vallisneria spiralis, a fac-simile of the plate in Darwin's "Loves of the Plants."

by what strange contrivances the fertilization of the seed is effected. In the Linnæan system this mode of fructification occasions the assignment of the plant to the 22nd class, *Diœcia*, and the second order, *Diandria*, that is, producing male and female flowers on different plants, and the male flowers with two stamens.

Vallisneria occurs, therefore, in two distinct forms, but only one of these forms, the pistillate, or female plants, is in general cultivation in this country; consequently the species is imperfectly represented, and opportunities for the observation of its complete fructification are rare, and as a corollary, staminate plants being wanting, the seeds produced by the pistillate forms are not fertilized, and we depend for the increase of the plant wholly on the production of offsets or runners, which are plentiful when the plant is properly treated.

Taken together, we shall see how Paley was justified in citing it in the first of the series of examples of peculiar adaptations of means to an end in the twentieth chapter of his "Natural Theology." But Paley was indebted to Dr. Darwin for the description, and we are all indebted to the fanciful author of the "Botanic Garden," and the "Loves of the Plants," for the first accurate representation of Vallisneria, which in a reduced form is here reproduced. In the last-named poem (l. 339), Darwin, according to his fashion of personification, introduces "Vallisner" as a water-nymph, sighing for union with her swain, in a passage that is now all but forgotten—

"As dash the waves on India's breezy strand,
Her flush'd cheek pressed upon her lily hand,
Vallisner sits, upturns her tearful eyes,
Calls her lost lover, and upbraids the skies;
For him she breathes the silent sigh, forlorn,
Each setting day; for him each rising morn.
Bright orbs, that light yon high ethereal plain,
Or bathe your radiant tresses in the main,
Pale moon, that silverest o'er night's sable brow,
For ye were witness to his parting vow!
Ye shelving rocks, dark waves, and sounding shore,
Re-echoed sweet the tender words he swore!
Can stars or seas the sails of love retain?
O guide my wanderer to my arms again!"

Then follows the celebrated note which Paley copies, and in which we have a short and clear description of the plant:—"This extraordinary plant is of the class of Two Houses [*Diœcia*]. It is found in the East Indies, in Norway, and in various parts of Italy, Lin. Spec. Plant. They have their roots at the bottom of the Rhone, the flowers of the female plant float on the surface of the water, and are furnished with an elastic spiral stalk, which extends or contracts as the water rises and falls; this rise or fall, from the rapid descent of the river, and the mountain torrents which flow into it, often amounts to many feet in a few hours. The flowers of the male plant are produced under water, and as soon as their farina, or dust, is mature, they detach themselves from the plant, and rise to the surface, continue to flourish, and are wafted by the air, or borne by the currents, to the female flowers. In this resembling those tribes of insects where the males at certain seasons acquire wings, but not the females, as ants. These male flowers are in such numbers, though very minute, as frequently to cover the surface of the river to a considerable extent." To this note Paley adds: "Our attention in this narrative will be directed to two particulars: first, to the mechanism, the 'elastic spiral stalk,' which lengthens or contracts itself according as the water rises or falls; secondly, to the provision which is made for bringing the male flower, which is produced *under* water, to the female flower which floats upon the surface."

But Dr. Darwin and Dr. Paley dealt with Vallisneria according to the custom of the dark ages; the microscope had not then introduced man to the inner world of life, and the cabinet of great secrets. This is, *par excellence*, a microscope plant, and it should be the aim of every microscopic beginner first to obtain it, then to keep it; the first an easy thing, the second not so easy. The culture of Vallisneria is, perhaps, the most engaging of all the tasks included in the management of aquaria, and that some few points in the process are of more than ordinary interest is proved by the fact that there is a general complaint amongst aquarians that in some tanks it will not live at all, and in most it is apt to perish after a brief season, or continue but in a languishing state. I have long ceased to employ it as an agent for the production of oxygen in fresh-water collections, trusting wholly to spontaneously-produced algæ in vessels containing molluscs and fishes. This sets the Vallisneria and kindred plants free for separate culture in proper vessels, and under more favourable circumstances than can be afforded generally in rectangular tanks. It may be observed, however, that there is no objection whatever to its use in vessels containing animals; it is most ornamental, and its bright refreshing verdure gives a high character to a well-stocked tank. The few risks that attend it in such cases result first from the voracity of water-snails, which, if present in the same vessel, are perpetually engaged in nibbling it to pieces; minnows and tench are apt to do the same thing, and in this way the plant is frequently destroyed faster than it can grow to compensate losses, and thus disappears, and has to be again and again replaced. Another difficulty is the occasional deficiency of solar light. I have explained, in the "Book of the Aquarium," in the chapter on the "Natural System of Management," that all phœnogamous plants need more light than the lower forms of vegetation. Tanks freely exposed to light are always favourably situated for Vallisneria, but this free exposure begets the growth of rope-like masses of confervæ; but to realize the perfection of a sufficient vegetation without a particle of undue growth, the light ought to be so far subdued as to be insufficient for this plant. Then we come to the appropriation to it of separate vessels, and a very pretty collection of Hydrocharis, Stratiotes,

Vallisneria, and other plants of special interest, may be kept in a 20-inch bell-glass in a south window or conservatory, with a shoal of sticklebacks to give it life and attraction. The confervæ would of course grow with its customary vehemence, but to keep it in check would be but a trifling matter compared with the trouble which a large vessel would occasion under the same circumstances.* Besides this advantage, there would be another: Into such a vessel three or four inches of clean yellow loam or good garden mould could be introduced, the roots of the plants spread out upon it, and then covered with two inches of sandy grit or small pebbles; but mould in a large tank is a nuisance and an injury. A still better method of growing Vallisneria is in tall cylindrical jars of flint glass, with flat glass covers cut to fit, and with only a few Hydræ, Hydrachnæ, or other small animals in company with it.

I obtain jars for this purpose of Mr. Lloyd, who marks upon them with a diamond the date on which they were first set to work, and then gives them a long seasoning before he parts with them, in order to reduce to a minimum the risk of fracture that attends the use of all blown vessels. Those I use measure 16 inches high and 6 inches wide, and cost 8*s.* 6*d.* each. In planting in these jars use what gardeners call "stiff loam;" press down very firmly at the bottom of the jar a bed of it two inches deep, lower the plant into its place, throw in a handful of fine shingle to cover the roots and keep the plant in its place, and then carefully fill up with clear river-water. The plant likes warmth and a good share of daylight, with occasional sunshine; hence a south window of a room in which there is a fire all winter is the best place for it, unless grown in a stove-tank, where it will grow in great luxuriance. Very few aquarians are aware that a periodical change of water materially assists the growth; say, if half the water is withdrawn by a syphon once a week, and replaced by an equal bulk of *tepid* water containing one drop of ammonia, then you provide for it the maximum of favourable conditions attainable in parlour culture. Frost does not kill it, but long exposure to cold cripples it so much that it should not be expected to flower the next season.

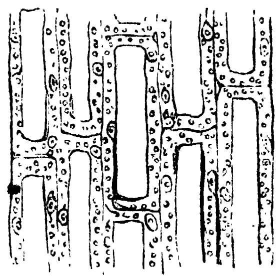
One result of your labour is, that at all seasons you will have before you a beautiful object, and in the season of its bloom a rare and curious example of adaptation to circumstances in a plant of unique habit and growth. For another result bring out the microscope, and if you have never yet enjoyed the spectacle which Vallisneria is ever ready to present to your view, prepare your mind for a sight which you shall never forget as long as you live, and have faculties for remembrance and adoration. Has any microscopist forgotten the sense of awe with which, in the early days of his researches, he watched the slow revolving granules of Chlorophyll in the mysterious chambers of Vallisneria, where life appeared to have its final seat? Has any gray-beard philosopher lost the recollection of the spell which bound him to the eye-piece, and the glare of reflected light on the object that seemed capable of explaining the great mystery, but which he had to learn explained but little, because, after all, its meaning was not understood? Impossible. Yet the march of those globular bodies in their liberal orbits, like stars in their courses, gave a freshening

* The best form of bell-glass for an aquarium is that made, at my suggestion, of white glass, with perpendicular sides, and known as "Hibberd's Shape," by Messrs. Phillips, 180, Bishopsgate Street Without, London, E.C.

charm to the first start in scientific inquiry, that has had its value ever since to keep him constant to his high vocation, just as the well-remembered "first love" is precious among the pleasures of memory to man or woman treading the downward path of life.

In order to observe the circulation in Vallisneria a few precautions are necessary. The plant should be in a vigorous state of growth, and in a warm room for a short time previous to being submitted to the microscope. Supposing this is not the case, the activity of the plant may be accelerated by a very simple process. The phenomenon is best exhibited by using thin longitudinal slices, cut from the leaf with a sharp thin knife. To make sure of a good result, a number of such slices should be cut and placed in a small phial of water and closely corked about an hour before the examination is to take place. In the meantime keep this phial in your waistcoat pocket, and the warmth will bring about the required state of activity by the time of the intended exhibition. It is as well to vary the experiment. Cut a number of thin sections, place some in a clear solution of gum-arabic, others in a solution of loaf-sugar, and others in milk, and the remainder in clear water which has been slightly tainted with ammonia by merely dipping into it a pencil which has been moistened with the alkali. These will produce their several effects in hastening the motion, and give additional interest to the examination for purposes of comparison. Begin with a power of 200 diameters; less is no use, but more will be required for a careful and intelligent examination. Now what do you see? The circulation of the sap? Nothing of the sort; that term misleads, and begets false and foggy notions of vegetable physiology in the minds of young students. You see a slowly-revolving galaxy of green globules of Chlorophyll; steadily and solemnly they pursue their suggestive gyrations; some, as if by centrifugal force, but really by resistance of the cell-wall, are thrown to the outer margin of the sedate miniature whirlpool, and remain behind while their fellows proceed in their stately course up one side, down the other, and it seems as if hidden within the secret chambers of the plant were myriads of vital engines united together in the clockwork of life.

It is a grand sight, an impressive and beautiful sight; and by it you may realize the one step from the sublime to the ridiculous, if by the aid of the pencil you attempt to represent it; and here is the poor picture of



the best of all the microscopic panoramas. The source of enchantment is the motion, and you cannot represent *that.*

What is the meaning of this phenomenon? Not the "circulation of the sap," as commonly understood, certainly. It is properly known as the ROTATION OF CELL CONTENTS, and such in truth it is. That it has immediate relation to the whole vital force, and distribution of nourishment and secretion of deposits throughout the plant, is not to be doubted. But the phenomenon of rotation presents itself in a peculiarly marked form in certain plants, and is not observed in others; so that whether it is a *general* or a *particular* phenomenon it is at present impossible to say. It may, however, be observed in *Chara, Nitella, Hydrocharis, Anacharis, Stratiotes, Potamogeton,* and some other plants of a high order in the vegetable kingdom, besides *Vallisneria;* some of the *Desmidiaceæ* exhibit it, as do also some of the liverworts,

but as a rule it has not yet been discovered in the cells of land plants. What you have before you is a series of cells in longitudinal arrangement. Each of these cells contains what is termed "protoplasm," or, say mucilage, and this mucilage rotates within the walls of the cell, and carries with it those globular bodies by which the motion is made evident, and which are globules of chlorophyll, the substance which gives the plant its green colour. The nucleus of the cell moves with the protoplasm, and is easily distinguished from the chlorophyll granules. The slices that are in gum and sugar will show a different kind of motion. Instead of the stately march of the globules in their orbits, you have now a movement in waves, and by removing the object, and injuring it by pricking or cutting it open with a knife, the movement will be arrested, but will gradually return in the uninjured cells by the influence of warmth.

There are thus four distinct subjects before us, when we place *Vallisneria* under the microscope—the Cell, the Protoplasm, the Nucleus, the Chlorophyll globules. These lead us into considerations more or less profound, according to our capacity of penetrating the mysteries of life. They lead us, too, into the toughest of disputations as to the relative importance of the several points themselves: as, for instance, whether the Nucleus is a vesicle, as asserted by Nägeli, or a solid body, as asserted by Griffith and Henfrey; whether the nucleus is of necessity attached to the cell-wall, or only so apparently; and why, for the purpose of life, it should have such a position. Whether the nucleoli within the nucleus are solid granules or cavities; and whether nuclei are the productive germs of cells, or the result of cell-development, irrespective of increase. To institute a careful comparison between the cellular phenomena of the plant before us, and that exhibited in the hairs of *Tradescantia*, will prove a safe procedure in the study of Vegetable Physiology, and at least a help in understanding the relative merits of the conflicting theories of cell-development, as well as of the actual importance of the several parts of the cell and its contents.

SHIRLEY HIBBERD.

LIGHT.

"Joyful be those
Who breathe in the rosy light."—SCHILLER.

No one can doubt that the pleasures of earth would be greatly diminished if we were not favoured with the presence of light. Light is one of those gifts from which none are deprived, and the commonness of which is the reason why its consideration is so much neglected by the generality of persons. It would be impious to say that the many phenomena connected with light are not attractive and important; and it may, therefore, be affirmed that the supposed unattractiveness, where this exists—and this is true as regards every inquiry into the operations of the Infinite—lies solely in the man; it is subjectively, or in the mind alone, that the imaginary dulness dwells. A few considerations into some of the phenomena of light will probably render the subject attractive to some who have not hitherto concerned themselves with it.

If we suppose light to be caused by the vibrations of some substance—and this is now the general idea—it must be concluded either that this substance continually surrounds us, and is thus only set into motion by the sun, or that it is daily thrown forth by that body.

The latter notion is, for many reasons, very improbable, and consequently the former, although it cannot be set down as proved, may philosophically be maintained. The sensation of light is in every case caused by the friction of some substance upon the eye, that is, by a species of motion or force. It is very necessary to remember, in every physical inquiry, that all force is some kind of motion. It is absolutely impossible to imagine the existence of force or power—which terms are synonymous—without the existence of motion, or rather which is not motion of some sort, inasmuch as it is known that absolute quiescence is never manifested as power. The particles of bodies cohere without man being able to perceive any kind of motion, although he is at once acquainted with the presence of amazing power, and consequently concludes that motion exists. It is true that the experience derived from the senses is insufficient to show that absolute quiescence is never manifested as, or the relative cause of, power; but the human reason is at once decisive upon the point. It cannot be supposed, inasmuch as a contradiction is involved, that the absence of all activity is productive of force or power of any kind, which is an activity which can be experienced. In chemical philosophy, the union of certain apparently quiescent substances is followed by great and this apparent motion; but, so far from proving the creation of force in this particular, the phenomenon shows that the substances were active when apart.

To the savage as well as to the philosopher there is attractiveness in colour; the tints of morning and evening, equally with the dyes of every flower, are things contemplated by both, although of course in a different manner. It is usual to say that the prism decomposes light, but this term is useless as an explanatory one, if intended to be understood in its chemical sense; and I apprehend that when it suggests any meaning, this is the sense generally affixed to it. If we suppose the vibrations of some substance, that is, any vibratory portion of it, to impinge upon a prism, and pass through it, and that its transit through the substance is the cause of its being broken up into a number of vibratory energies, that is, a number of separate vibrations running through different parts of it, each of which falling upon the eye produces a separate sensation, and is known as a separate colour—and I think that this supposition is the most probable one, or, looked at in connection with others which may be maintained, the probable one—I see not how this can be set down as decomposition, unless the term is allowed to express in general the issue of a number of forces out of a single force; and I apprehend that this extension would be injurious as having a tendency to confusion. If we restrain the term to chemical action, which may briefly be set down as a series of mechanical motions, impalpable because undistinguishable by the eye, touch, or any other human sense, and not as yet capable of discernment by any artificial contrivances, no confusion can arise; but by using it as regards phenomena which appears to be wholly of a mechanical kind, no advantage would be obtained, while many would probably be confused with erroneous ideas respecting many purely physical phenomena. The atmosphere acts as an immense prism. When the sun is tolerably high and unobscured by fog, no colour is seen; but when it is lowering, or before its appearance in mid-air, or when the atmosphere is vaporous, we see colour. When the solar rays fall upon any observed part of the atmosphere at a considerable angle, they are broken up, and the various vibratory lines, the impressions of which we denominate colours, are refracted in various degrees. When these colours fall upon clouds, or pass through vapour, they are darkened, and this is no doubt caused by the weakening and consequently diminished rapidity of the vibrations.

It cannot but be supposed that when a substance in vibration is reflected from off any surface, or transmitted through any other substance, the vibrations will be weakened. When the solar rays penetrate a fog, or when the sun is observed through a piece of lamp-blackened glass, it appears red; and this is caused by the deadening effects of the intervening media, but cannot, nevertheless, be set down as something depending upon the breaking up (decomposition) of the rays, inasmuch as it cannot be said that even one other line of vibration (colour) is experienced. As regards the glass, we know that this is not the case, and the action of the fog appearing to be similar, and experience giving nothing to the contrary, the same thing may philosophically be supposed of it. It may be concluded that the so-called absorption of light, which appears in the deadening or darkening of its colour, which things are not the same, is caused by the checking of the luminous vibrations or undulations.

If the inner corner of either eye is rubbed by the hand, rings of coloured light, and not merely coloured rings, will be seen apparently at the opposite corner, which proves, I apprehend, that the sensation of light is produced by friction upon the eye. However produced, it is a popular observation, that when the eye is heavily struck, a flash of light appears to proceed from it; and as it appears that the swifter the friction produced the more intense is the colour of the light and the light itself, it may be concluded that the sensation of white light is produced by the most intense friction. It is easy to imagine that the vibrations of some ethereal medium produce a quicker friction upon the eye than man can imitate. In considering intensity of colour apart from intensity of light, it should be remembered that there is no reason for supposing the mere colour of a red or blue flame to be less intense than that of a pencil of the solar rays, if the darkness of each colour is the same, and this can be judged of. It does seem, however, that the intensest light affords the darkest colour.

It is commonly stated that the colours by which objects are distinguished are the reflected rays, and that consequently the other rays are absorbed; but a little consideration will show that the term absorbed conveys no more meaning than that it is something different to reflection, that is, unless the person using or hearing it is at the trouble to give some attention to the question. When the solar rays fall upon any object they are reflected, receiving more or less vibrational disturbance according to the nature of its surface, and of course produce the sensation of some colour accordingly. To say that the sensation of white is the reflection of all the solar rays is true; but it is as false to assert that black is the absorption of them all, inasmuch as, to have any meaning to our words, we must here also allow that the vibrational lines, the matter of light, is under a different kind or degree of vibrational disturbance.

The solar light is scattered from off unpolished surfaces, because, being reflected by the atmosphere, it falls upon them, and this of course equally as regards polished surfaces from all directions, and also because, which does not apply except to a very small extent to the latter objects, they are uneven, which causes the light to be reflected from off them in a great number of directions. It should be remembered that every ray is thrown upwards according to its incidence upon the respective point of the surface, or, which is the same thing, that the coincidence of the incident and reflected angles exists as in the case of polished surfaces. When it is said that more light is reflected from some than other angles, it must be understood either that more points are so positioned as to reflect it, or that it is less weakened by the process of reflection, or that both of these effects occur. A cannon-ball which

only glances against some unmovable object loses little force, and so the light which is reflected at a small angle is the most intense, and this apparently irrespective of the increase of the number of points from which it is reflected, inasmuch as there is no reason for supposing that, as a rule, this increase occurs upon the diminution of the reflected angle. Of course, where this augmentation occurs, the quantity of light reflected or its intensity is increased; but it cannot be said in what case the increased quantity of light is in any degree owing to the greater number of points from which it is reflected, that is, as regards the altered position of any particular surface. And as to other surfaces at the same angle, the same thing must of course be said, where as before a little difference in this respect could not be ascertained even by photometric means. From analogy to palpable physical effects, it may be concluded that the luminous vibrations are weakened in proportion to the size of the angle at which they come into contact with either polished or rough surfaces, and also that the light and colour reflected from all surfaces diminish or increase in intensity regularly, at equal reflections, in equal or different light, as far as the position of the surfaces in their entirety is concerned; and it is consequent upon the latter point that, if various surfaces are placed at the same angle, the difference between the least and the most intense light or colour may be set down as owing to surface phenomena, supposing any to be appreciable either by the eye or photometric means, although it cannot be affirmed that the least intense light or colour is not augmented in comparison to what it would be at some angle or angles, by the exposure of a greater number of reflecting points, that is, points so situated as to reflect the light falling upon them at the respective incident angle to the eye.

It thus appears that we can effect by comparison that which cannot be done by the inspection of merely a single surface, even when viewed at a number of angular positions. It is a fact very worthy of observation, and one which does not appear to be generally understood, that there is not any, what may be called radical, distinction between light and colour. The colour of a brick-wall is produced by the red rays of the solar beam, that is, by those vibrational lines which produce the sensation of red, and is therefore as much light as any unbroken ray which proceeds directly from the sun to the eye. Upon the common doctrine of the decomposition of light, as a number of luminous rays unfolded out of a particular one, it is impossible to understand, with any amount of clearness, how those colours which cannot artificially be brought out of the white ray, to make use of the common phrase, are produced; and inasmuch as it may be found, in one way, by transmitting light through coloured glasses, that the various coloured lights can be broken apart, or that different colours appear, the doctrine of their decomposition, using this word in its proper sense, as implying previous composition or union, and that of the white ray, do not appear to agree, inasmuch as it is here said that a certain substance is composed of certain other substances, and that each of these is made up of, at any rate, some of the elements, if difference in degree is not allowed to explain the variations in colour forming the original substance.

The solar and all other luminous rays are reflected by brilliant metallic surfaces and polished substances of every kind, and it is found that the colour of these substances disappears in proportion to the perfection of the polish, which fact is deserving of popular inquiry and interest in a considerable degree. It is, I think, clear that the colour is produced by those points which do not reflect the light, that is, which are unpolished; upon which supposition the gradual disappearance of the former element into the perfection of

the polish is at once capable of explanation. Reflection depends upon the adjustment of the eye. In looking upon a polished surface of bars, or any other polished substance, we may see either the unreflecting points or only a mass of colour; or, by a different adjustment of the eye, we may behold those external objects from which rays fall upon the reflecting surface. And this distinction is a very observable one. Besides the distortion produced by reflecting surfaces of unequal curve and contour, it should be remembered that, and this on account of imperfection of polish, no surfaces reflect all degrees of light equally, the less intense portions of the reflected objects suffering a disproportionate amount of weakening, so that no reflection, even from a plane mirror, is really the image of the object except as regards its form.

The various uses of light, heat, and actinism, especially as regards the vegetable kingdom, afford inquiries which none but the most ill-assorted minds can look upon with carelessness. It is wonderful that a ray of white light can be broken up into a number of coloured rays; and human surprise is increased when it is found that the same ray is capable of being broken up apparently into three elements. I avoid the word decomposed, inasmuch as there is not any proof of a previously compounded state, and also because a substance in a state of vibration, which light is here supposed to be, must be looked upon as something simple. As regards solar light, it may be supposed that the vibrations affecting the eye as light, affect the sense of feeling as heat, and thus that these phenomenal experiences arise from the same cause; and where, as in the case of the lunar rays and those proceeding from phosphorescent bodies, light is experienced apart from heat, it may be concluded that the vibrations are insufficiently energetic to be discernible by tactual experience. It is found that the proportion of light, heat, and actinism in the solar ray is not constant, but varies with the several seasons. In the spring the actinic principle is most abundant; in the summer light and heat are in excess; and at the time of autumn the heating rays are most powerful. I have elsewhere ("Mechanics' Magazine," vol. i., No. 6, new series) given a supposition by which to explain these phenomena, and it is this—that the solar atmosphere is made up of three sorts of matter, and then sends forth these various rays as the earth is turned towards it. It may be supposed that every ray of each kind is broken up, and thus gives rise to the (in appearance three, but in reality) two elements which are found to exist. If we suppose rays of light, whether solar, artificial, or otherwise, to be vibrational lines, or, indeed, in any way to produce friction upon the eye, it is only philosophical to allow that the same friction is produced upon every part of the human frame which is exposed to it, and thus has some effect whether or not this is experienced. Consequently it may be supposed, although I do not say considered as proved, that the cause of the solar light, and so of every other light which is mixed with heat, is also the cause of the accompanying heat. The action of athermanous bodies is thought to prove that light and heat are independent substances; but all that can be made out of the experiment is, that a number of rays, which before appeared to affect the physical frame as heat—I do not give any supposition, but speak merely as regards appearance—do not then so effect it, or in any other experienced way. It is easy to imagine that the vibrational parts of any substance are so altered by being transmitted through certain media, that, while continuing to affect the eye as light, they are not in any way experienced by the frame as heat. It would, however, be unphilosophical to suppose that actinism is only a modified condition of the vibrational lines permeating the luminous and apparently calorific substance; because it is found, by the use of a piece of

dark cobalt-blue glass, as a medium through which the light is to be transmitted, that the presence of this element is unaffected, whereas only a considerable amount of light is obstructed; and it may, therefore, be concluded that actinism is a separate element, inasmuch as, if it is supposed to be converted or transformed light, the question of heat may be omitted; as this is not, at any rate as regards anything unusual to the senses, a necessary ingredient, it is impossible to explain why all the light is not so transformed. If no light were obstructed, it could not be said that the actinic element is not that which affects the eye as light; and if all were prevented, it might be said that the actinic element was, while preserving its chemical power, so altered as to be useless as a luminous agent; but, inasmuch as it is found that only some light is destroyed, and the whole of the actinic power remains, the experiment, as proving the distinctness of the latter element, may be considered a crucial one. As regards the identity of light and heat, I of course only allude to these experiences when occurring together, except with reference to the lunar rays, phosphorescent and other bodies, where light only is discernible, for artificial heat can be produced without light; and when, as in the case of a red-hot bar of iron or other metal, the calorific rays become luminous, we must conclude that a new species of friction is exercised upon the eye, inasmuch as, by comparing the heat of dull iron or other metal with the greatest solar heat, the question of degree at once appears to be untenable. It may, I think, be concluded that all heat which is not accompanied by light is caused by the vibrations of some ethereal medium, from the fact that heat of this kind is found to traverse the Torricellian vacuum; and the experiment of Boyle, which is the production of frictional heat in an exhausted receiver, by the abrasion of two pieces of metal.

The experiment which consists in painting upon a circular surface the colours of the solar spectrum, and causing this rapidly to revolve, and which is sometimes, but erroneously, stated to produce white light, the colour being, as has been remarked, a neutral one, proves the retention of impressions upon the retina; and, along with the phenomena of complemental colours, and others which have been alluded to, proves also, I think, that the physical sensation of light—I say physical, inasmuch as there seems to be mental sensation or impression, as well as perception of every object—is caused by friction.

The appearance of the nocturnal sky is sometimes very striking, and at first remarkable. A number of openings appear amid a mass of black or dark-blue or gray clouds, and through these the white or gray light of the upper atmosphere is strangely visible. It must be allowed that the light appears more intense than it really is from contrast, nevertheless its presence is not by many at first, if at all, understood. It is caused by the numberless refractions of the solar rays proceeding from the sun, then below us, and it may be beneath our feet; and these rays are thrown upon the clouds, and impart to them or their thinner portions their luminous appearance, which at that time has a peculiar aspect.

The study of cloud colour in its effects is one for the painter, and the philosopher should seek to acquaint himself with the causes of these phenomena; and so of the colours of seas, rivers, mountains, forests, and, in fact, of the earth generally. It is often difficult to understand how cloud colour is produced, and much can be learnt by surveying the face of the underlying country, and considering what effects are worked by the reflections of the objects there found to exist.

The colour of rivers and seas and all waters is determined by their depth and the state of the atmosphere, or the reflection or non-reflection of the sky or surrounding air.

It may be said to increase in intensity with their depth, for water is not a colourless fluid, and therefore its colour is intense in proportion to the length at which those rays which emerge to the eye pass through it.

J. A. Davies.

GALVANIC BATTERIES, AND HOW TO MAKE THEM.

A galvanic battery is an instrument so frequently required by all engaged in electro-chemistry, that any clear information respecting the construction and management of such a piece of apparatus is pretty sure to be welcomed by a large number of that class of experimenters.

We therefore propose to devote an article to this subject; not with a view, however, of describing all, or even many, of the different kinds of battery that have been invented. Most of them are interesting only from an historical point of view, and only three or four out of the entire number invented are used to any extent in the present day.

Presuming, too, that our readers prefer making a battery for themselves rather than purchase the parts and merely put them together, we shall treat the subject in such detail as under other circumstances would be quite uncalled for.

Before the tyro commences any experiment in this line, we would advise him to make himself acquainted, if he have not done so already, with the use of the soldering-bit. To be able to handle this tool readily will facilitate many of his operations, and perhaps save him much mortification and disappointment. Any tinman could teach him in ten minutes how to use it well.

Apart from mere handling, there is a little chemical expedient, to which the experimenter may have recourse when he wishes to solder two surfaces together. After cleaning the surfaces to be thus united, apply to them a thin film of chloride of zinc with a small camel's-hair pencil. On bringing the hot soldering-bit, charged with a drop of solder, into contact with these surfaces, the metal will spread out in a thin bright film upon them; and if the bright surfaces are now brought together, and the soldering-bit again applied, they will be readily but firmly united.

To make the *chloride of zinc* just mentioned, take about a dessert-spoonful of hydrochloric acid (spirit of salt), drop into it two or three scraps of clean zinc, and a piece of sal-ammoniac about the size of a nut. When the mixture has ceased effervescing, and while some zinc still remains undissolved, strain off the clear liquid and put it in a bottle till wanted for use.

We are thus minute at commencement, because our early experience taught us the unspeakable misery of seeing our soldered joints tumble apart just as we were in the midst of some interesting process, and the scarcely less tolerable torture of burning our fingers in ineffectual attempts to repair them. If the foregoing directions are adhered to, no such trying mishaps are likely to occur.

The simplest form of battery that can be turned to any practical use is that represented in Fig. 1. Z is a plate of zinc, about four inches long and one inch wide. C a plate of copper, of similar dimensions. Each has a copper wire soldered to its upper extremity. The vessel, M N, may be a common preserve jar of about three inches diameter. It is filled within an inch of the top with dilute sulphuric acid (oil of vitriol); say one part acid to six of water. If the

two plates be now immersed in the liquid, as shown in the figure, chemical action immediately commences in the neighbourhood of the zinc plate, and bubbles of hydrogen gas will be seen to rise to the surface of the liquid. After a short space of time this action ceases. Now let the clean ends of the wires *a* and *b* be brought into contact, and chemical action recommences with increased vigour; and, provided the wires be kept in contact, will be continued for a considerable space of time.

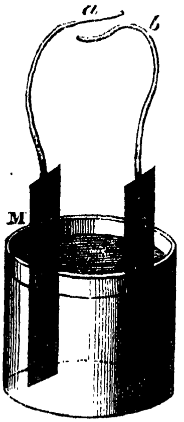


FIG. 1.

It is of some importance to learn, and to remember, the *direction* which an electrical current thus formed invariably takes. Note, therefore, that the two metals are very unequally acted upon by the acid. The zinc is vigorously attacked, the copper very slightly. Always start from the metal attacked, and remember that *this plate* is negatively electrified, while *the liquid* in its immediate vicinity is positively electrified. The positive electricity thus set free is conducted by the liquid to the copper plate, and from this plate through the wires back again to the zinc from whence it started, and thus the *circuit* is complete. The circulation of the fluid continues, though with diminishing vigour, for a few hours, after which it becomes quite powerless. Hence this simple form of battery is not used in those processes which require a constant current to be kept up for several days together. If, however, the zinc has not been all eaten away by the acid, the plates may be taken out and cleaned, after which they can be used again till the zinc is consumed.

Supposing the tyro to have constructed a battery of the form above described, he may satisfy himself of the wonderful power that resides in it by an experiment which never fails to delight every one who performs it. In short, he may now construct an electro-magnet, and his little battery will be quite sufficient to set it in action.

To make the magnet, take a piece of half-inch round rod-iron, and bend it into the form of a horse-shoe. File the ends flat, and provide it with an armature, as shown at c (Fig. 2). Cover the horse-shoe with insulated copper wire, that is, copper wire wound with silk or cotton. It may be purchased ready covered, or, for a first experiment, common bonnet wire may be used. If the ends of the wire, *a* and *b*, be now connected with the corresponding ends, *a* and *b*, of the battery (Fig. 1), the electrical current will circulate through the coil which surrounds the magnet, and impart to it the power of holding up a considerable weight. As soon as the connection between the battery and magnet is broken, the latter becomes powerless, but when the connection is renewed the magnet resumes its attractive force.

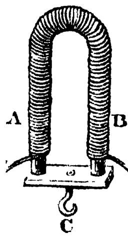


FIG. 2.

The connection between the wires may be made by simple contact, by solder, or by means of binding screws, such as shown in Fig. 3. The last is, on the whole, the most convenient method; they may be obtained of the instrument-makers at sixpence each.


FIG

We have already intimated that the power of a battery, constructed in the simple manner just described, diminishes in the course of a few hours to such a degree as to become useless unless the plates are taken out and cleaned. As, however, it is important in many electrical processes to be able to maintain a current in full efficiency for se-

veral hours, and even for days together, other forms of battery have been devised with a view to attain this end.

To understand the principle on which these improved batteries are constructed, it is necessary to glance at the cause of that diminution of power which occurs in the simple cell. This cause is threefold: first, the acid loses its power in consequence of its combining with the oxide of zinc, forming the sulphate of zinc, and which is held in solution in the remaining acid; secondly, a portion of metallic zinc is deposited on the surface of the copper plate, so that the latter, instead of performing its proper functions, acts in some measure as another zinc plate; thirdly, minute bubbles of hydrogen gas attach themselves to the surface of the same plate, and so still further impede its action. Now, the main object aimed at in the construction of the next battery we are about to describe, is the prevention of these deteriorating influences from coming into action.

The most effective and available contrivance of this kind is that known as Daniell's Constant Battery. It consists of three parts, represented in Fig. 4. The vessel, *a*, is of copper, and must, unless the experimenter be very skilful in mechanical manipulation, be made by a coppersmith. The bottom is quite water-tight, and near the top is acircular perforated shelf, also of copper. In height it may be six, eight, ten, or twelve inches; in diameter about three or four. Into this is fitted the porous jar or diaphragm, *c*. The method of making these diaphragms is described in vol. i. of RECREATIVE SCIENCE, p. 278; or they may be bought at any chemist's. The rod, *b*, is made of solid zinc. To cast it, get a small round ruler or smooth stick, wind it round three or four times with stout brown paper, and embed it upright in fine dry sand, within half an inch of the upper extremity of the paper. After ramming the sand down tight all round it, withdraw the ruler, and the mould will be ready to receive the metal. The zinc may be melted in an ordinary iron ladle over a kitchen fire, and the casting will be the more perfect, if care be taken not to heat the zinc much above the melting point. Into the upper end of this zinc bar a stout brass wire should be screwed or soldered, and the wire may then be surmounted by a binding screw.

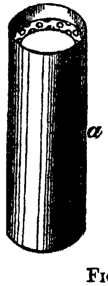


FIG. 4.

Now, to put this battery in action, prepare a saturated solution of sulphate of copper in water, and in another vessel a mixture of sulphuric acid and water in the proportion of one of the former to seven or eight of the latter. Place the porous jar within the copper cylinder (see Fig. 5), and within the jar the zinc rod, keeping it steady by means of corks or slips of wood. Then fill the space between the porous jar and outer cylinder with the copper solution, taking care to lodge a few crystals of the sulphate on the perforated shelf, in order to keep the solution in a saturated state. Now pour the dilute acid into the porous jar; it will immediately attack the zinc, and if the wires *m* and *n* be brought into contact, an electric current will be immediately established; or these two wires may be connected with any other piece of apparatus through which it is desired a current should pass.

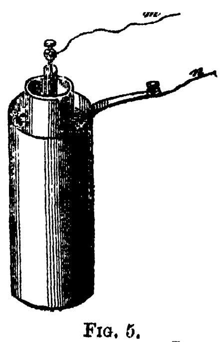


FIG. 5.

The efficiency of this battery is somewhat increased by adding sulphuric acid to the copper solution to the extent of one-eighth of its bulk.

The chemical action which goes on in this battery admits of the following explanation, which is substantially the same as that given by Professor Miller in "Elements of Chemistry." Let Cu (*cuprum*, copper), repre-

$$Cu\ \ \overbrace{Cu\,SO_4}\ \ \overbrace{Cu\,SO_4}\overset{P}{\Big\|}\overbrace{H\,S\,O_4}\ \ \overbrace{H\,S\,O_4}\ \ Zn$$

sent the copper plate or cylinder, Zn the zinc element, and P the porous diaphragm; the dilute acid may be regarded as a compound of hydrogen (H), sulphur (S), and oxygen (O), and may be represented in chemical symbols by $H\,S\,O_4$. In like manner the sulphate of copper may be represented by $Cu\,SO_4$. Let the brackets above the row of symbols represent the connection of the particles which compose the liquids before contact is made between the copper and zinc elements by means of the connecting wires, *m* and *n* (Fig. 5); then the brackets below the row of symbols will indicate the altered molecular arrangement of the liquids after the connection is made. Beginning at the right extremity of the symbolic row, we observe that the zinc is attacked by the sulphuric acid, forming sulphate of zinc, and setting one equivalent of hydrogen free. The same change takes place among innumerable molecules at the same instant, though two only are represented here. At length we reach the porous diaphragm, P, where an atom of hydrogen is set free, and this passes through the diaphragm to unite with sulphuric acid on the other side, forming liquid sulphuric acid, and setting an equivalent of copper free; this combines with another equivalent of acid, setting another equivalent of copper free; and so the change goes on, till at length an equivalent of copper, having no acid at liberty with which to combine, is deposited on the internal surface of the copper cylinder. In this way it is that the copper cylinder always retains a copper surface, and for this reason it is called a *constant* battery.

We would counsel the practical electrician to make himself thoroughly acquainted with this form of battery. It is the one which of all others he will find it most economical and convenient to use. The materials of which it is composed are cheap and always accessible; a combination of several cells may easily be formed by means of wires and binding screws; and it will answer as well as any for experiments with an electro-magnet, a coil-machine, in electro-metallurgy, or in the production of the electric light; while a battery of twenty cells will be sufficiently powerful for all ordinary cases of chemical decomposition. Moreover, it is susceptible of certain modifications, which in no way impair its efficiency, but which render it possible for the operator to make nearly every portion of a very powerful and efficient battery for himself. These modifications we make it our next business to describe.

Instead of the outer copper cell take a plain sheet of copper, and bend it round in the form shown in Fig. 6; solder on a slip, *a*, and procure a well glazed jar, of about the same height as the copper cylinder. A convenient size would be six or eight inches

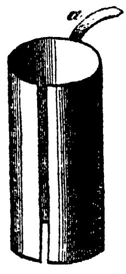


FIG. 6.

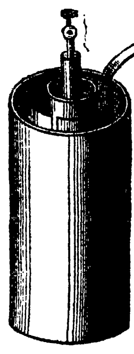


FIG. 7.

in height, and three and a-half in diameter. Place the cylinder within the glazed jar, and the porous jar within the cylinder (Fig. 7);

then proceed exactly as with the cell in Fig. 5, charging it with the same liquids, and steadying the whole arrangement with corks.

When a number of cells are to be connected together in a battery, the connection between the copper of one cell and the zinc of the next may be simplified, and a number of binding screws dispensed with. Let the brass wire at the top of the zinc rod be furnished with a thread and nut, the threaded portion being smaller in diameter than the lower part, so as to leave a shoulder on which the copper slip, *a* (Fig. 8), may rest. Or a binding screw may be attached to the top, as in Fig. 5, and a copper wire instead of a flat slip brought from the cylinder to it.

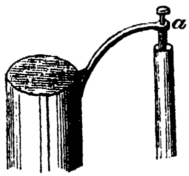


Fig. 8.

But more important than all, let the student make himself intimate with the principles on which the instrument is constructed, and he will not fail to discover numerous expedients by means of which the neatness and elegance of his apparatus may be increased, and expense diminished.

While, however, the above form of battery is the one which is most commonly used and is most easily made, we think it desi-

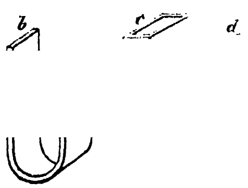


Fig. 9.

rable to show briefly how another may be constructed, of still greater power, and yet occupying much less space (Fig. 9). This apparatus was invented by Mr. Grove and bears his name. It consists of the following pieces:—1, a porcelain cell, *a*; 2, an element of amalgamated zinc, shown at *b*; it is surmounted with a binding screw, and the zinc is amalgamated by rubbing over the surface with dilute sulphuric acid and afterwards with mercury, by means of a small bundle of cotton wool or any other suitable material; the mercury becomes immediately incorporated with the zinc at its surface, forming an amalgam of zinc; 3, a smaller porous diaphragm, *c*, to drop between the folds of the zinc; 4, a thin plate of platinum, *d*, to go inside the porous vessel, and furnished with a screw.

The essential parts of this apparatus when put together are shown in section (Fig. 10). The porous cell is filled with strong nitric acid; the zinc element is surrounded with dilute sulphuric acid, as in the batteries before described. A number of cells may be connected, precisely as in the case of Daniell's battery, and when properly constructed it forms a combination of great power. Hence it is much used by electricians, and has contributed largely to extend the boundaries of electrical science. There is an objection to its use which deters many from availing themselves of it; fumes of nitrous acid are given off all the time it is in operation, and these are hurtful to the constitution and injurious to other articles of apparatus.

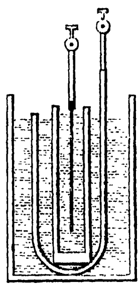
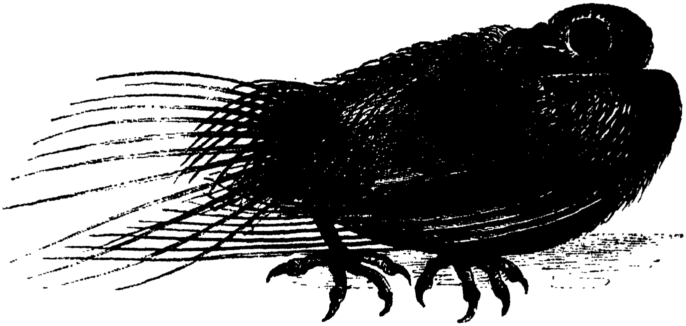


Fig. 10.

R. Bithell.

The Planet Mercury was seen by the naked eye, on Sunday evening, March 3rd, 6h. 45m., at Winchester, by the Rev. E. Firmstone, F.R.A.S. It will be most favourably situated for observation during the present month, on the 12th, at 7h. 8m. P.M., when it is at its greatest elongation west.



COMMENTS UPON THE MUMMY OF A PIGEON.

Our sketch represents a pigeon so completely exsiccated as to be, in fact, a natural mummy, not perhaps quite so well preserved as the best from the catacombs of Thebes, but still in very good preservation. How it became so is a point which we shall attempt to elucidate.

On two or three occasions we have seen birds in a similar condition, and once possessed a swift pretty nearly in the same mummified state as the pigeon before us.

By way of preliminary, let us observe the singularity of the plumage, to which we shall again advert. Many feathers are wanting, but the most essential, viz., those of the wings and tail, remain; not, indeed, vaned as they were when the bird was alive, but only in the form of naked shafts, with very slightly rugose edges, indicative of the former presence of these important parts of a feather.

The specimen in question was presented to us, by a celebrated ornithologist, as well worthy of our consideration in more than one point of view.

Its presumed history opens a field for reflection. Carefully have we examined it; it has never been wounded by shot, and from the solidity of the bones and the roughness of the legs, together with the worn appearance of the claws, it is evident that the bird was aged.

It was found underneath the tiles of an old house when roofing repairs were going on, and this is all that our friend could learn respecting it. It is not likely that a cat could have driven it there—its wings would have insured its safety; besides, where a remarkably large pigeon could find room to hide itself, a cat would also find room to enter in pursuit. It might, perhaps, have been pursued by a hawk, and so driven to take refuge, but this is not likely. It was evidently a very strong-winged bird, capable of rapid flight; and, besides, it need not, in order to escape such an emergency, have crept to so great a distance from the spot in which an entrance was most likely to have offered. Let us again repeat that it was a very old bird. Now it is a remarkable fact, that out of the thousands of birds in our woodlands, copses, hedgerows, and open fields, which must perish annually, not by the gun, but by age, sometimes, perhaps, by cold and starvation, or even by diseases, few such dead birds are ever found. Where, when they feel the approach of mortality, do they secrete themselves, ante-dating their own sepulture? Where do they await the close of existence? Some, perhaps, retire to the hollows of trees, to the matted herbage of dense hedges, to any sort of refuge, hole, or cranny, so as to retire from the observation of their former

associates. Be this as it may, seldom are their remains detected. We might pursue this subject, for our observations are of general import. Referring for a moment to mammalia, we are impressed with facts of a similar nature. It would, indeed, appear that the quadrupeds of a district have, according to their species, certain common dying-places. For example, Mr. Darwin in his researches ("Voyage of the Beagle") observes that the guanacoes (Patagonia) "appear to have favourite spots for dying in. On the banks of the St. Cruz, the ground was actually white with bones in certain circumscribed places, which were generally bushy, and all near the river. On one such spot I counted between ten and twenty heads. I particularly examined the bones. They did not appear as some scattered ones which I had seen gnawed or broken, as if dragged together by beasts of prey. The animals, in most cases, must have crawled before dying beneath and amongst the bushes. Mr. Bynoe informs me that during the last voyage he observed the same circumstance on the banks of the Rio Gallegos. I do not at all understand the reason of this, but I may observe that the wounded guanacoes at the St. Cruz invariably walked towards the river. At St. Jago, in the Cape de Verd Islands, I remember to have seen, in a retired ravine, a corner under a cliff where numerous goat's bones were collected. We at the time exclaimed that it was the burial-ground of all the goats in the island."—(P. 197.) It occurs to our recollection that something of the like import has been said about the mammalia (elephants, lions, antelopes, etc.), of Africa, but we can cite no definite authority. Is it going too far to imagine that, in some cases at least, birds may have similar dying retreats? What becomes of the tenants of a crowded rookery, or of the countless flocks of rock-doves along the precipitous cliffs of our coast, and especially of the Mediterranean? What of our larks, starlings, even of our sparrows? They die. How often are their remains discovered? They certainly (so we think) do not collect in dying-places. The pigeon of the dovecote must be regarded as a domestic bird, and it is not often, perchance, that it attains to the natural term of its existence. That some do so we cannot doubt, and, as we ourselves can testify, old occupants are now and then missed. Cats or hawks, nay, even owls (innocent of pigeon's blood), bear the blame. Have they not, in many instances, retired to die? And was not such the case with respect to the specimen before us? Let us suppose it to have crept away, wearied and worn out, into the recess, wherein its remains were discovered.

But then its shrivelled, mummy-like condition, and the peculiarity of the plumage.

The place in which it died must have been remarkably dry, and protected from atmospheric changes, perhaps even warmed by a kitchen chimney, whence radiated a sufficient drying heat. No mice or rats had attacked it. It lay with its legs distorted, its head reverted, as if it would have put it under the wing had it been able; and in this attitude the bird expired.

But why do the shafts of the feathers only remain? What has become of their respective vanes?

This denudation of the shafts is evidently owing to the work of insects; most probably a species of *Tinea*, of which the ravages of the larvæ are so well known upon feathers, furs, felt, woven woollen, silks, etc. Many persons, we may here observe by way of digression, think, when they see the mischief in their drawers or wardrobe, and behold the number of moths which fly out or lurk under covert, that these are the actual depredators. Not so; the business of these moths is to lay their eggs in a suitable *nidus*, and then leave them contentedly. From these eggs spring multitudes of voracious close-biting larvæ, which really commit the mischief. In due time these become quiescent pupæ, wrapped

up in delicate cocoons of the material upon which the caterpillar or larvæ fed (feather-fibre, wool, silk, etc.), and thence issue the perfect moths.

For several years, perhaps, were these larvæ of the *Tinea* (clothes'-moth) busy, generation succeeding generation, on the plumage of the bird before us. The strong-rigged varnished shafts remaining untouched, as defying their efforts, while the vanes became eaten away to their very root.

So do we account for the denudation of this dried-up mummy-bird. Now let us examine more attentively into this fragmentary feather-clothing. The "lay" of the plumage, which was obscured during life, is admirably exhibited, each "layer" preserving its due order, superposition and direction. On the back, it is true, some feathers, not the most important, have perished; but those of the wings and tail are well preserved, and display an interesting object of contemplation. Let us first consider the wings. In the specimen of this shaft-clothed pigeon, the elastic stalks (*les tiges*) of the primary quill-feathers are perfect, as are those of the secondaries. Those of the greater wing-coverts are also preserved, but those of the lesser wing-coverts are less perfect and somewhat disturbed. The shafts, remarkably stiff, of the bastard wing, or *alula*, are nearly entire, and there is a good tuft of those of the scapularies. The haunch-bones are almost denuded, and the breast-bone presents only a scattered few, and that on one side only, the bone of the sternal keel being exposed on the other, as if the skin had been over-dried and cracked. There are fair remains of the coverts on the inside of the wing, but not in full completeness. The neck and head are bare, but the marks of those on the head have a rather pretty appearance; the thighs are denudated. The tail-feathers are nearly perfect, and have many both of the upper and under tail-coverts *in situ*; of course, we mean their shafts.

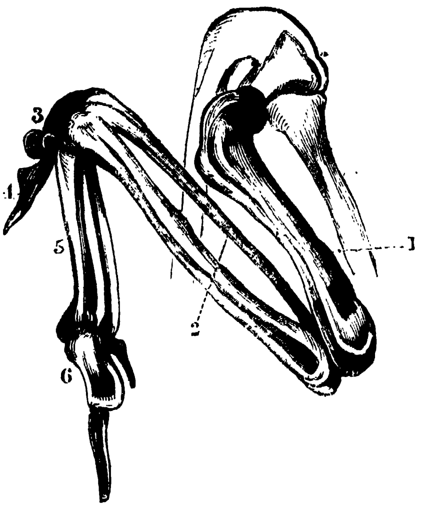
All these shafts are preternaturally rigid, reminding us of the texture of slender porcupine's quills; the effect, no doubt, of drying heat and preservation from moisture.

Now much that we have said respecting *primaries*, *secondaries*, *coverts*, etc., will be unintelligible to those who have not paid attention (and many such there are) to the arrangement of the plumage of birds, and sorry we are to say they gain but little help, and often misinformation, from so-called popular works on ornithology, while those of a more pretending nature, grand works and elaborate treatises, say nothing about the matter. We do not look to a Gould, an Audubon, a Wilson, a Selby, a Yarrell, a Bonaparte, *cum multis aliis*, for any information on such a point. It is taken for granted that the reader is acquainted with this rudimentary part of ornithology, the outlines, as it were, of his grammar. But experience has proved to us that comparatively few general readers entertain clear ideas on this subject. May we not, therefore, be pardoned if we here offer, in succinctness, some elucidatory observations? Of the general clothing of the head, neck, and chest, we have little to say. The feathers of these parts, except in remarkable cases, are, like the fur clothing of a quadruped, intended for warmth, and are more or less full and soft, as need may be. But when we come to the grand organ of flight, the case is different; here we need efficient agents.

We annex the bones of the wing of a bird of great powers of flight, a consideration of which will enable the reader better to understand the feathering.

1 represents the humerus; in some birds it is very stout and short, but is hollow within, containing rarefied air, derived from the great air-cells of the interior of the body, with which it communicates by means of an aperture. It is inserted at the joint, by means of a long, narrow, articulating head, into a shallow cavity, formed chiefly by the coracoid

clavicle, but partly by the upper extremity of the long narrow scapula, or shoulder-blade. But the merry-thought or anterior clavicle, varying in shape and strength in different birds, does not enter into the construction of this articulating pit. These parts are merely indicated in our sketch. The ligaments of this joint, the true shoulder-joint, are very powerful, and to this the great pectoral muscles and also the elevator muscles of the wing contribute greatly. Hence, unlike the shoulder of man, which rotates freely, the motion allowed is very limited; indeed the



Osseous Structure of Wing.

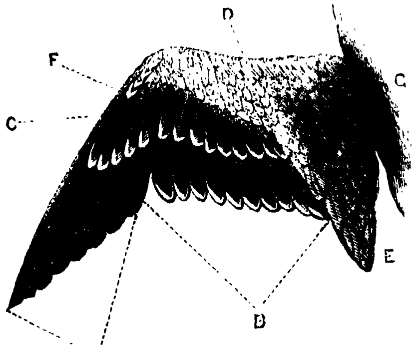
upper portion, in common language, is imbedded in the flesh To the humerus succeeds two bones (2), constituting the fore-arm. These are the ulna and radius. They are strongly knit by ligaments at the elbow-joint; of the two bones the ulna is the stout one, the radius being slender. The fore-arm of man, the radius to which the hand is attached, enjoys the power of pronation and supination. Not so the fore-arm of the bird; it is capable only of extension and flexion, as the wing is stretched out or folded; and it firmly beats the air, the shoulder-joint participating in this action during flight. To the fore-arm succeeds the carpus, or wrist (3), consisting of two or three small bones which enter into the wrist-joint. Here again the motion is limited. Just below the wrist is inserted a jointed bone (4), which may be regarded as the almost fixed thumb, and which carries the stiff little feathers of the bastard wing. From the wrist-joint (3) proceed two long bones, which represent the *phalanges* (row of bones immediately below the wrist) of the human hand (5), one of these bones is stouter than the other, but neither possess free motion. To the phalanges (5) succeed (a joint separating them) the finger-bones. The first row (6) consists of a large flattened bone concave in the centre, with a small posterior style-like process. To the large flat bone is attached a small slender bone, terminating the hand, for such this part is, although in a rudimentary condition. How unlike the human hand, but how much better fitted for the purpose it has to subserve.

Infinite are the variations in the strength and development of the bones of the wing; but in general not only is the *humerus* a hollow, air-filled cylinder, but the bones of the fore-arm also. By this method strength and lightness are combined. Such is the osseous frame-work of the wing of a bird, which hundreds who neatly carve a fowl do not understand, and neither use nor know the correct terms applicable to any portion. The idea of a hand is out of the question.

Having thus sketched the osseous framework of a bird's wing, let us consider the feathering, and turn to our drawing—the wing of a snipe from nature.

A, the primary quill-feathers, stiff, with firm elastic shafts, and well-knit vanes. They arise from the upper surface of the bones of the hand (the thumb-bone excepted), and take an oblique direction downwards. The oblique quills are set in close compact array, and present a very beautiful appearance; the number of these feathers is ordinarily ten,

in some cases twelve. They are of main importance, and if cut close the bird is incapable of flight. When the wing is natu-



rally folded, the primaries slip under the secondaries.

To the primaries succeed B, the secondary quill-feathers, broader and shorter than the primaries, and by no means so rigid. They are supported by a strong membrane, which fixes them to the lower edge of the ulna, or larger bone of the fore-arm, and take an oblique direction, the small quills being closely compacted, but the shafts are more or less inclined to present a backward flexure, particularly in such birds as the lapwing, golden plover, snipe, and others of the same tribe. They amount generally to ten in number, or twelve.

The basal portion of these primaries and secondaries is overlaid and supported by C, the greater wing coverts, which arise both from the hands and the bones of the fore-arm, and present in many birds a most distinct and elegant row, as in the example before us. Their great utility is in adding to the firmness of the primaries and secondaries, and defending their basal portions from rain. The base of these great wing-coverts is covered by D, the lesser wing-coverts. These arise from the bones of the fore-arm, and overlapping each other, the lower feathers, being longer than the upper, form an efficient protection, different in density and softness in different birds. In the humming-birds, with their long, rigid, narrow-pointed wings, these feathers are metallic in appearance, and also in the sun-birds of India and Africa.

If we run down these feathers to E, we shall observe that they become much elongated, and terminate in a point. In many birds little of this arrangement is to be seen, but in the snipe, dunlin, lapwing, golden plover, and the tringæ and scolopax, etc., the length of these feathers is very remarkable, and they evidently influence the character or style of flight. They are really continuations of the lesser wing-coverts, but in some descriptions of the feathering of birds we have seen them denominated *tertials*. Now, did they arise from the humerus, then this appellation would be just. Such, however, is not the case, and indeed this extraordinary elongation is not universal. What see we of them in the swift and humming-bird?

Let us now turn to the letter F. We have spoken of the little thumb-bone at the wrist-joint, just below the carpal bones. Upon this are placed several stiff, short, adpressed feathers, which probably add to the firmness of the base of the first two or three greater coverts. They may strengthen the joint, but their real use is somewhat problematical.

At the letter G we have just indicated the humerus; it is covered with a continuation of the lesser coverts, but often gives off from its posterior edge feathers more decided than ordinary, which cover the sides of the back, running in the direction of the scythe-like scapula. These have been termed scapularies, but the utility of the term is doubtful. Wherein, as a general rule do they differ from the dorsal feathers generally? Occasionally, we do not deny, some such distinction may be made. But the less indefinite names are multiplied, the better.

Now, let us look at the under surface of the wing. We find there a series of inner

lesser coverts, followed by a series of greater coverts, answering to those upon the outer aspect, but of a softer texture and less definitely developed, although in many birds, as the golden plover, snipe, and others, they are well marked and distinct.

Such, then, is an outline of the feathering of a bird's wing, but multitudinous are the diversities which this organ of flight presents throughout its entire development. Into such details we cannot attempt to enter.

The same observations apply to the tail feathers, which are inserted into the sides of the *os coccygis*. These differ in extent, number, and character *ad infinitum*. Above they are protected by coverts, uropygial feathers (*uropygium*), wonderfully developed in the peacock. Underneath there is also a layer of coverts (*crissum*), whence are obtained the marabou plumes, so esteemed for their lightness and beauty.

But we must conclude. We might extend our observations to an unwarrantable length. But this must not be.

It is evident that certain elementary definitions must be understood and remembered by those who hope to make any kind of progress in scientific knowledge. Ornithology is no exception to the rule, and the diligent inquirer may obtain the key to at least one branch of the science by a careful study of so unattractive an object as a mummy pigeon. W. C. L. Martin.

ASTRONOMICAL OBSERVATIONS FOR APRIL, 1861.

The Sun is in Aries until the 20th, and then in Taurus. He rises in London on the 1st at 5h. 38m., on the 10th at 5h. 18m., on the 20th at 4h. 56m., and on the 30th at 4h. 36m.; setting on the 1st at 6h. 31m., on the 10th at 6h. 46m., on the 20th at 7h. 3m., and on the 30th at 7h. 19m. He is above the horizon in London on the 1st, 12h. 53m., and on the last day 14h. 43m.

The Sun rises at Edinburgh on the 9th at 5h. 12m., and on the 20th at 4h. 44m.; setting on the 9th at 6h. 54m., and on the 20th at 7h. 15m. He rises at Dublin on the 7th at 5h. 23m., and on the 29th at 4h. 31m.; setting on the 7th at 6h. 42m., and on the 30th at 7h. 26m.

Day breaks in London on the 1st at 3h. 49m., and on the 29th at 2h. 14m.

Twilight ends on the 2nd at 8h. 33m., and on the 30th at 9h. 48m.

Day breaks at Edinburgh on the 3rd at 3h. 25m., and on the 29th at 1h. 55m. At Dublin on the 11th at 3h. 0m.

Length of day in London on the 1st, 12h. 56m., and on the 28th, 14h. 30m.; at Edinburgh on the 12th, 13h. 55m.; at Dublin on the 17th, 14h. 6m.

The Sun is on the meridian on the 1st at 12h. 3m. 54s.; on the 15th at 11h. 59m. 59s., and on the 30th at 11h. 57m. 4s.

The equation of time is on the 1st, 3m. 54s. additive; on the 15th, 1s. subtractive, and on the 30th 2m. 56s. subtractive (or after the Sun).

The Moon is new on the 10th at 6h. 56m. a.m.

Full Moon on the 24th, at 10h. 23m. p.m.

She is at her greatest distance from the earth on the 10th, and at her least distance on the 24th.

Mercury is a morning star in Pisces. He is at his greatest west elongation on the 12th, at which time he is in a favourable position for observation. He rises on the 1st at 5h. 1m. a.m., and on the 26th at 4h. 13m. a.m.; setting on the 1st at 4h. 16m. p.m., and on the 26th at 4h. 53m. p.m.

Venus is in Pisces at the commencement, and in Aries at the end of the month. She is badly situated for observation, and very small in apparent size. She rises on the 1st at 5h. 29m. a.m., and on the 26th at 4h. 40m. a.m.; setting on the 1st at 5h. 27m. p.m., and on the 26th at 6h. 48m. p.m.

Mars is in Taurus and becoming fainter. He rises on the 1st at 7h. 7m. a.m., and on the 26th at 6h. 20m. a.m.; setting on the 1st at 11h. 5m. p.m., and on the 26th at 10h. 56m. p.m.

Jupiter is a very conspicuous object in Leo. He rises on the 1st at 1h. 7m. p.m., and on the 26th at 11h. 29m. a.m.; setting on the 1st at 4h. 15m. a.m., and on the 26th at 2h. 37m. a.m.

Saturn is also in Leo, rising on the 1st at 2h. 38m. p.m., and on the 26th at 12h. 54m. p.m.; setting on the 1st at 4h. 54m. a.m., and on the 26th at 3h. 14m. a.m.

Uranus is in Taurus. He rises on the 1st at 7h. 44m. a.m., and on the 26th at 6h. 9m. a.m; setting on the 1st at 11h. 54m. p.m., and on the 26th at 10h. 21m. p.m.

Occultations of Stars by the Moon:—On the 5th, θ Aquarii ($4\frac{1}{2}$ magnitude) disappears at 3h. 21m. p.m., and reappears at 3h. 57m. p.m.

On the 14th k Tauri ($5\frac{1}{2}$ magnitude) disappears at 7h. 17m. p.m., and reappears at 8h. 13m. p.m.

On the 19th ο Leonis ($3\frac{1}{2}$ magnitude) disappears at 1h. 41m. a.m., and reappears at 2h. 29m. a.m.

On the 26th σ Scorpio ($3\frac{1}{2}$ magnitude) disappears at 10h. 35m. p.m., and reappears at 11h. 38m. p.m.

On the 30th π Capricornii (5th magnitude) disappears at 2h. 58m. a.m.

Eclipses of Jupiter's Satellites:—On the 5th, at 12h. 41m. a.m., 1st moon reappears. On the 6th, at 7h. 10m. p.m., 1st moon reappears. On the 7th, at 3h. 49m. a.m., 2nd moon reappears. On the 12th, at 2h. 36m. a.m., 1st moon reappears. On the 13th, at 9h. 5m. p.m., 1st moon reappears. On the 14th, at 8h. 13m. p.m., 4th moon disappears. On the 15th, at 12h. 54m. a.m., 4th moon reappears. On the 16th, at 7h. 16m. p.m., 3rd moon reappears. On the 17th, at 7h. 44m. p.m., 2nd moon reappears. On the 20th, at 11h. 0m. p.m., 1st moon reappears. On the 23rd, at 7h. 43m. p.m., 3rd moon disappears. On the 23rd, at 11h. 15m. p.m., 3rd moon reappears. On the 24th, at 10h. 20m. p.m., 2nd moon reappears. On the 28th, at 12h. 55m. a.m., 1st moon reappears. On the 29th, at 7h. 23m. p.m., 1st moon reappears. On the 30th, at 11h. 48m. p.m., 3rd moon disappears.

Stars on the Meridian:—On the 1st, Spica Virginis souths at 7h. 27m. p.m. On the 1st, Arcturus souths at 5h. 36m. p.m. On the 11th, Spica Virginis souths at 6h. 47m. p.m. On the 11th, Arcturus souths at 4h. 57m. p.m. On the 11th, α Hydra souths at 8h. 1m. p.m. On the 13th, ε Hydra souths at 7h. 11m. p.m. On the 16th, Regulus souths at 8h. 21m. p.m. On the 18th, δ Leonis souths at 9h. 19m. p.m. On the 20th, β Leonis souths at 9h. 46m. p.m. On the 22nd, β Corvi souths at 10h. 23m. p.m. On the 24th, γ Virginis souths at 10h. 23m. p.m. On the 26th, Spica Virginis souths at 5h. 50m. p.m. On the 26th, Arcturus souths at 3h. 58m. p.m. On the 26th, β Corvi souths at 10h. 8m. p.m. On the 29th, Spica Virginis souths at 10h. 46m. p.m. On the 30th, Arcturus souths at 11h. 34m. p.m.

E. J. Lowe.

METEOROLOGY OF APRIL.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Mean Temperature of the Air. Degrees.	Mean Temperature of the Dew Point. Degrees.	Mean Pressure of the Air. Inches.	Mean Amount of Cloud. (0—10).	Number of Rainy Days.
1846	48·7	—	29·578	7·9	20
1847	45·9	40·7	29·667	4·9	18
1848	47·1	39·4	29·668	6·6	22
1849	43·0	35·7	29·878	6·7	18
1850	47·4	42·4	29·577	7·5	22
1851	45·1	37·6	29·738	6·9	17
1852	46·3	38·9	29·993	4·9	4
1853	46·8	38·3	29·714	8·2	23
1854	46·4	38·8	30·009	4·9	5
1855	44·9	35·5	29·924	6·0	9
1856	46·1	40·6	29·571	7·2	17
1857	45·5	38·8	29·609	8·5	18
1858	46·0	37·4	29·803	6·3	10
1859	45·0	38·5	29·595	7·2	16
1860	43·6	38·0	29·459	8·0	13
Mean	45·8	38·3	29·720	6·8	15½

The mean temperature of the air of the last fifteen years, for April, is 45·8°, the range in the mean temperature being from 43° in 1849 to 48·7° in 1846—a difference of 5·7°. The lowest means occurred in 1849 and 1860; and the highest in 1846, 1848, 1850, and 1853.

The mean temperature for April, of the last fifty years, is 47·3°, and it was as high as 51·1° in 1814, and as low as 42·3° in 1837.

The mean temperature of the dew-point for the last fourteen years, for April, is 38·3°, the range being from 35·5° in 1855 and 42·4° in 1850—a difference of 6·9°, the lowest means occurring in 1849 and 1859; and the highest in 1847, 1850, and 1856.

The mean pressure of the last fifteen years, for April, is 29·720 inches at the height of 174 feet above the mean sea-level, ranging between 29·459 in 1860, and 30·009 in 1854—a difference of 0·550 (above half an inch). To reduce these readings to the mean sea-level, it is necessary to add 0·189 of an inch, when the mean temperature is as low as 43·0°, as in 1849; and 0·186 of an inch when it is as high as 45·7°, as in 1846. On applying this correction, the mean pressure, of the last fifteen years, when reduced to the sea-level, is for April 29·908 inches.

The mean amount of cloud, for April, of the past fourteen years is 6·8 (or under seven-tenths of the whole sky); the amount being as much as 8·5 in 1857, and as little as 4·9 in 1847, 1852, and 1854—a difference of 3·6 (or above a third of the whole sky).

The mean number of rainy days, for April, of the last fifteen years is 15½, ranging between 4 in 1852 and 23 in 1853—a difference of 19 days. The years of but little rain are 1852, 1854, and 1855; and of much rain 1848, 1850, and 1853.

E. J. Lowe.

THE MICROSCOPIC OBSERVER.

APRIL.

Hymenophyllums.—The filmy ferns are now in full growth, and their new and delicate fronds are in the best possible condition for microscopic purposes, though it is only the leaf-structure that can be observed at this season. The delicate stems will readily exhibit the scalariform ducts, and the rhizomes will afford ramenta in the best possible condition for the exhibition of their cellular structure and arrangement. The leaf consists of a single layer of cells, through which ramify scalariform ducts to form the veins, and there are no stomata. If a thin slice shaved off a young leaf of *Pteris aquilina*, now easily obtainable, be submitted for comparison, it will be found that there is an upper and lower epidermis, plentifully furnished with stomata with cellular tissue, through which ramify the fibro-vascular bundles, the cells of the epidermis having zigzagged walls, which have a most beautiful appearance under the microscope. The ferns which produce gemmæ on the leaves are now in a fair condition of new seasonal

growth for observation of the viviparous mode of reproduction. *Asplenium flabellifolium* is just now putting out complete miniature plants from the terminal points of its pendant fronds. *Scolopendrium bulbiferum* will be found to have already formed its gemmæ on the edges of the fronds of the season's growth, and sections of these should be made for an examination of their structure.

INFUSORIA are now abundant in clear runnels of fresh water, about head-springs, and in all ponds and ditches. In the last-named sites only the commonest kinds occur; the rarer sorts must be searched for in clear brooks, among wet sphagnum, and the drainage waters of chalky and sandy districts. Suggestions have been offered, in the papers by Mr. Tuffen West and Mr. H. Slack, in these pages, for collecting and preserving the various kinds commonly met with. To observe them with advantage the live-box should be used first, and when their general characters have been determined, and their movements understood, place them between the slide and cover in a small quantity of water, in order to observe the contractile vesicles and general organic structure. Warmth will stop their motions. The following are the most common in natural waters and infusions:—*Chilodon cucullulus*, *Chlamidomonas pulvisculus*, *Coleps hirtus*, *Colpoda cucullus*, *Euplotes charon*, *Glaucoma scintillans*, *Monas crepusculum*, *gliscens*, *guttula*, *termo*, *socialis* (in water-butts), *flavicans* (ditches), *Paramecium chrysalis*, *colpoda*, *Stylonychia pustulata* and *mytilus*, *Uvella glaucoma* (in water-butts, and a good subject to feed with indigo), *Vorticella convallaria* (on the surface of vegetable infusions), *V. microstoma* (stagnant water), *V. chlorostigma* (the last often covers grasses and rushes with a beautiful green layer).

SECTIONS OF DIATOMACEOUS SHELLS.—Schleiden proposed, in his "Principles of Botany," a plan for obtaining transverse and oblique sections of Diatomaceous shells, that has been found of great value in practice, and eminently adapted to the range of manipulations usually undertaken by the amateur. The pure deposit of siliceous shells is mixed with mucilage, and the mixture allowed to harden, but not to get quite dry. Delicate slices are then taken off in a slanting or vertical direction with a razor, and the slices mounted at once or examined first to determine whether they are worth it.

OUT-DOOR STUDIES.—That famous orobanchaceous plant, *Lathræa squamosa*, is now in bloom, and offers its services in illustration of the theories of embryology, and especially of the labours of Schacht in that department. It is usually found in beech-woods. About twenty-five species of willow are now in flower. Saw-flies may be found about pear, apple, and gooseberry trees, seeking for places in which to deposit their eggs. The abundance of spring flowers and new verdure will furnish objects without number, and it will be found a good rule to take the first that presents itself, and determine all its points of interest as to structure and relationships before proceeding further in search of reputed rarities.

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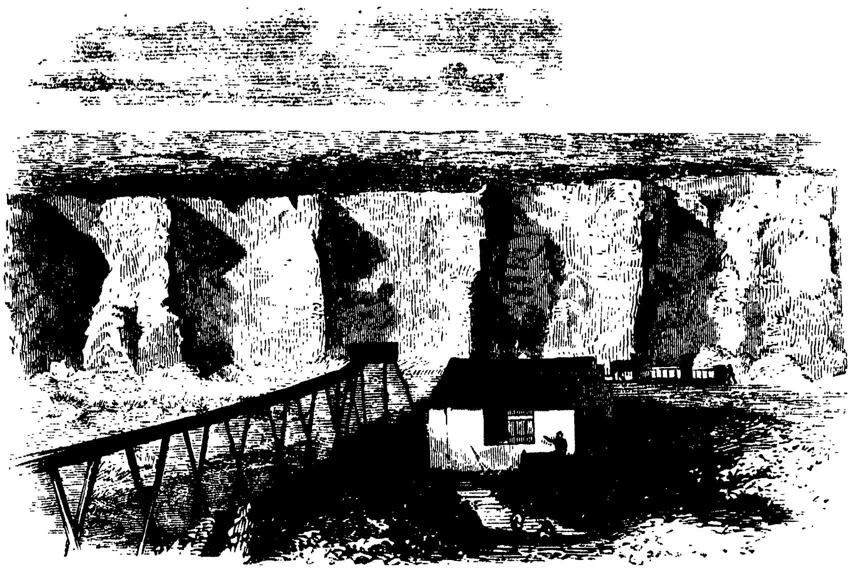
Mr. Noteworthy's Corner.

ENCOURAGEMENT FOR AMATEUR ASTRONOMERS.—The Royal Astronomical Society have this year awarded their gold medal to M. Hermann Goldschmidt, of Chatillon-sans-Bagneux, France, for his discovery of eleven minor planets. The following sketch of M. Goldschmidt's astronomical career is epitomized from an address lately delivered by the Rev. R. Main, President of the above Society. I propose to place it on record in the pages of RECREATIVE SCIENCE, in the hope that some of its readers will be induced to emulate the enterprising German. "Lutetia, the first planet discovered by him, is estimated at the 9-10 magnitude, a size which we probably would not have thought of looking for with any object-glass of less than four or five inches. Well, this he discovered with a telescope of hardly two inches aperture, such a one, in fact, as you see frequently used at watering-places for looking at ships, etc. This telescope was one of which the young astronomer might well be proud. It, or a smaller one of one and a-half inches aperture, which it replaced, was purchased with the proceeds of the sale of a copy of a portrait of Galileo, which he had painted at Florence. Never, perhaps, were so great results accomplished by such small means, and if this be, as is generally supposed, an attribute of genius, M. Goldschmidt may fairly claim the admiration which is due to it. A telescope of two inches aperture, placed in the window of a garret, forming the sleeping apartment of the astronomer, is made, by judicious handling and severe scrutiny of the Berlin star-maps, to discover one of a class of objects which it taxes to the utmost the astronomers of Greenwich to observe, when it is found with the great transit circle. By the practice of a most rigid economy, M. Goldschmidt became able to purchase another telescope, an improvement on the preceding, having an aperture of two and a-half inches, and even with such an apparently inadequate instrument he discovered four more planets. Subsequently obtaining a telescope of four inches aperture, he discovered eight other planets. None of his telescopes were mounted equatoreally, but in the greater number of instances they were pointed out of a window which did not command the whole of the sky. And I now leave you to form your own opinion of that fertility of invention and resource, that steady determination to conquer apparently insurmountable difficulties, the untiring industry and never-failing zeal which realized such splendid results with such inadequate means." Worthily, indeed, do such men as Goldschmidt deserve all the gold medals and honour we can give them.—G. F. CHAMBERS, *March* 15, 1861.

COMPLEMENTARY COLOURS.—In regard to optical phenomena, allow me to observe that in a church I formerly went to, two adjacent panes of one window were respectively dark-blue and amber-coloured glass. When the blue was all but hidden by the intervention of a column between it and the eye, a deep scarlet colour appeared on the margin of the amber.—W. C. R.



THE CHALK-PITS AT GRAYS, ESSEX.

Many as are the natural advantages of the site on which London has risen, it is pretty certain that extensive tracts of fertile soil, and the proximity of a river which affords quick communication with the Continent and the great sea routes to distant ports, are not alone sufficient to account for its immense wealth, and the rapidity with which it absorbs the surrounding country into its embracing mural arms.. The peculiarities of the subsoil and of the strata that crop out in all directions round it, have had as much to do with its attainment of the first position in the world as a commercial city, as any natural flow of commerce to it on the broad bosom of the once silvery Thames. The strata on which London stands are an inexhaustible quarry of the best of building materials ; the London clay, the London sand, the London chalk ; these furnish the raw material for the growth of London ; man has evoked a city out of the dust beneath his feet. Doubtless the fact of the metropolis of England holding the position it does, is so far dependent on the previous accumulation on the spot of the raw material of a vast city, that on any other formation than a basin of the tertiary the Thames would never have carried on its bosom the trade of a city which has no parallel for populousness, enterprise, and political influence, in either ancient or modern times. No matter in which direction a traveller proceeds from the City outwards, he must pass over a storehouse of natural wealth. In approaching the suburbs he finds, by the beauty of the gardens, that taste, and ease, and munificence have cheerful invitations to the culture of the soil; for the natural surface loams are remarkably fruitful, and adapted to a greater variety of vegetation than

any other natural surface soil in Great Britain. On reaching the districts where building operations are proceeding—for, like Pau-puk-keewis, the song that London sings is "make me larger, make me larger"—he observes that there is the clay on the spot, there are the bricks burning night and day; and as fast as the clay is exhausted, foundations are made, and the town extended. Sand and clay frequently come from the same excavations, and there is only wanting the lime to cement the whole together, and, Eastward ho! there is lime in plenty on the margin of the Thames.

Among the number of chalk-pits from which the chief supply of lime for London is derived, that at Grays Thurrock, on the Essex margin of the Thames, on the line of the London and Tilbury Railway, is certainly the most interesting; though on the Kent shore there are some grand excavations, and many local attractions for an observer of natural phenomena. Quitting the Grays station of the Tilbury line, to be reached in less than an hour from London, a short walk to the left brings us to the pit, which we enter by a cutting in the fashion of a country road, flanked by chalky banks, barely high enough to shut out the view of the surrounding scenery. But this road into the pit is also a railway, and we have to step out of the line as a train of trucks laden with chalk, with a miniature locomotive to lead the way, comes dashing along on its way to the wharf, where the lighters receive their white cargoes. Pursuing the course of this railroad, we observe the road itself is on the level, or has but a trifling fall forward, but that the inclosing banks rise higher and higher, so as to shut out the view entirely, and at last assure us that we are in the pit. A turn to the right, and we have before us a magnificent amphitheatre of artificial cliffs, inclosing an area of about sixty acres, the whole of which has been excavated into the face of a stratum of chalk upwards of 100 feet in thickness, capped by a layer of ferruginous sand or foundry loam, which forms a rich red band along the upper course of the cliffs all around us, in beautiful contrast to the chalk below it which is here and there dashed with green or ochreous weather stains, but generally of an intense and glaring white, almost unbearable to the untrained eye when the sunshine is full upon it. The very first object that arrests our attention in this vast gorge is that which we really came to see; a spring of water, bubbling from horizontal fissures of the chalk, at the lowest levels of the excavations, the persistency and copiousness of the outflow of which utterly prohibits any deeper working of the pit. To see these springs is alone worth the journey to Grays, and any honest inquirer will find a welcome there. You may have visited all the famous water scenes, the lakes, the tarns, the sources of great rivers, but never have you seen water under so peculiar an aspect as it has here, in a couple of tanks cut in a bed of chalk in the face of the cliff, where the spring gushes perpetually like a thread of quicksilver. It must be a bright day without a cloud; then the chalky bottom of the tanks which receive the water have a strange tinge of cobalt blue, broken here and there by the metallic green of patches of confervæ. The water is so bright and still that you cannot be quite sure that you are looking upon water at all; it blends its mass with the chalky bed, with the mingled hues of intense white, mysterious blue, shadowy grey, and shining green, so as to appear like a vast polished mirror, or, if such a thing can be imagined, like a mass of transparent metal coated with hyaline. These are the celebrated water-springs of Grays Thurrock, destined perhaps to play an important part some day in supplying this over-growing London with one of the first necessities of life.

Our object in visiting these springs in company with some scientific gentlemen, on a recent occasion, was to learn by inspection and report what were the probabilities of the

water supply being appropriated to the use of Londoners, instead of being, as now, pumped away and wasted to the amount of two million gallons every twenty-four hours. That point we will not here dwell on, except to express a hope that Mr. Meeson, the proprietor of the pit, may some day find that the vein of water is as good as a vein of gold, as we are already certain that it is less exhaustible, and of far greater importance as an aid to the extension of London eastward. To see the water issue like a silver cord agitated along its whole length, and to see it translucent in the tanks, under circumstances that might be new and startling even to Mr. Ruskin, is to enjoy a pleasure only to be experienced in a chalk-pit—nowhere else could such colouring be effected or such water be found. It is almost as cold as ice, it is of the same temperature all the year round, utterly colourless, sparkling, contains not a trace of organic matter, hard enough to prove refreshing to the palate, the very perfection of water for those who like it pure, and—iced. Where does it come from? Where does it go to? We will answer the second question first, for the first is not so easily answered.

Turn about and make for yon hillock tufted with valerian, saintfoin, ragwort, and yarrow. Now you have before you the whole of the grand scene. Here comes the train of chalk waggons, empty now, on their way to the escarpments on which the pick and the shovel are at work. The locomotive is a skeleton—you can see through it: it is about the size of a four-wheeled cab, and in the midst of the few cranks and levers that suffice for propulsion, stands the grim stoker, a sort of Vulcan, riding the ghost of Pegasus in the nether regions. Right across, under the face of the cliffs, is the spring and its extraordinary reservoir. You cannot see it now, but you see instead a pretty brook matted with water-cresses, with here and there a tuft of forget-me-not, all growing in rampant luxuriance on a bed of pure chalk, and without a particle of what we ordinarily call soil. An attendant gnome, white as a miller, and learned in the physiology of chalk, informs us that once upon a time some of the workmen threw a few sprigs of water-cress into the brook; they got entangled, struck root in the chalk, and thence the brook became a water-cress bed, for the supply of the myriad appetites that enterprise has here brought together. This brook is fed from the tanks below the springs, and conveys the water in waste to the Thames, but as the springs when left undisturbed rise only about eight feet below highwater mark, steam power is used as the balance of gravity, and yonder is the engine-house, where five pumps are kept in action night and day by two eight-horse and one six-horse engines. The way to the engine-house is also the way to a whiting factory, where the chalk is triturated, mixed with water, and started on a quick journey through a complexity of narrow runnels, during its course through which the grit is removed from it by subsidence, and the pure soft chalk or whiting is the result. This brings us to another structure where the whiting is moulded into blocks, stored on open battens to dry, and thence sent to London for the delectation of the housemaids. "Plenty of foraminifera there," we say to the gnome, as we behold the milky stream hurrying from runnel to runnel. "It's nearly all foraminifera," he says, and Mr. Meeson adds that chalk is wholly organic, and he is the happy proprietor of more fossils than could have been counted by Adam, had he begun on the day of his creation, and been spared to go on with his counting to this present hour. Happy man, to have excavated sixty acres of cretaceous organisms, and have before him, through the mass of that grand wall of rugged chalk, at least five square miles of the same deposit, of pretty much the same thickness.

We take another turn. Having wandered far to the left, and made an irregular ascent, we come upon the soil that overlies the chalk

beyond the excavations, to the top of the cliff; in fact, a hundred and twenty feet above the railway and the works. We make a turn to the right, up the face of a steep hill of ferruginous sand or foundry loam, which is of great value in metal casting, and is contracted for by Government for use in cannon-foundries. This "loam" is strictly a fine sand, almost wholly free of alumina, containing a considerable proportion of iron oxides, and rich in minute organic remains, of which the siliceous shells of diatoms form probably

The Watercress Brook.

the predominating ingredient. A few stunted pear and plum trees show that vegetation does not abhor it, but luxurious growth is out of the question. The rabbits are, perhaps, the best crop produced on these steep sandy hills that flank the pit. A romantic alley cut through the bed of sand leads the way to Mr. Meeson's cottage, which is perched up on the top of the cliff, in the centre of a lovely garden, and which, as strictly private, we have no right to name here, except to say that, from the side of the garden next the pit, there is one of the finest prospects within a range of twenty miles of St. Paul's, and that is into the pit itself and its sublime semicircle of excavations. Looking forward, the gigantic walls of chalk, capped with the uppermost layer of "foundry loam," assume the appearance of vast unhewn pillars, each pillar being a separate escarpment, caused by the cutting of the chalk in perpendicular sections. Between these there are the breadths of shadow caused by the recession of the sections cut away, so that light and shade alternate; the huge juttings, white as snow, reflect the sunshine; the vertical cuttings are darkened with gray, as if columns of mist rose through them, or, giving way to imagination as we keep the eye fixed, as if they were "everlasting doors" to some cave of Elephanta, or to the subterranean regions of the dead. By degrees we find we can trace out the horizontal layers of black flints, at regular intervals, along the whole face of the cliff, in the shadowy recesses, as well as on the glittering projections of the broken buttresses. Here and there a red streak, washed by the rain from the layer of ruddy earth lying over the chalk, betrays that it is a long while since the pick was plied upon that portion of the rock; and wherever these weather stains appear, there were dashes of vivid green herbage sprinkled all over with crimson and yellow flowers.

Colt's-foot is one of the first plants to appear where the chalk is left for a time to the tillage of Nature. Where the red sand crumbles down, and forms a thin layer over the chalk, grasses and clovers soon form luxuriant patches, and every hillock becomes a hummock carpeted with the little yellow suckling, and dotted all the summer long with scarlet poppies, golden ragwort, the rich purple of saintfoin, and the cheerful

blossoms of valerian. The botanist will find here above two hundred species of plants, the majority of which have their root-hold in pure chalk, others a little of the hungry sand to help them, while below, to prove what chalk will do, is the bed of water-cresses in the ice-cold water, as luxuriant in appearance and delicious in flavour as the best cresses of the market-garden. A sudden report, like an explosion, and a cloud of white dust recall us from these botanical scrutinies. A mass of chalk has been loosened from the summit on the opposite side, and it has gone down with a crash which every one of the pillars and recesses repeats in echo, and as the cloud clears away we see the workmen like mice burrowing into the cretaceous mass. This carries the eye downward, and what a scene! The ghostly locomotive is hurrying to and fro with its train of cars like a comet; right across on the further side are the mysterious water-tanks; close beneath us lime-kilns emitting columns of black smoke, that by contrast with the chalk heighten the picturesqueness of the prospect; up here is the sublime of Nature—the ramparts built by successive generations of foramanifera, diatomaceæ, corals, sponges, echinites, infusoria, during ages that baffle arithmetic to count them; down there the bustle of man, by whose mice-like burrowings this vast chasm of sixty acres has been made by the slow process of hand-labour, for blasting is rarely resorted to. It is not a passage from the sublime to the ridiculous, but from the sublime to the still more sublime, for the work of centuries may be undone in one day by those little moving human dots, who powder stone into daily bread; and the great city we have just left has absorbed the whole solid contents of the sixty acres of nummulites, spicules, crystalloids, and molluscous debris, to cement together the miles and miles of structure, for which the staple was furnished from the clay nearer home. There is not an ounce of soil from any part of these vast works but is rich in organic remains, and not an ounce that does not find its way when once loosened from the native beds into some department of human industry. The chalk furnishes lime and whiting, the red sand is used for moulds in metal castings, and the flints are burnt and used in the manufacture of the finest kinds of pottery. Truly, London is not only well placed beside the majestic flow of the Thames, and in the centre of the most productive soil in the whole of the island; it is also built upon a mine of material wealth; the city was hidden underground ere man began to clear a place to rest in among the marshes and woods that overspread the scene in the last days of the alluvial deposit. He has only called the city forth from its subterranean chamber, and, lo! there it is yonder on our left, like a cluster of black clouds on the horizon, with the dome of St. Paul's in the midst, the sharpest and darkest cloud of all—the city which has grown so great mainly by the circumstance of its geological position.

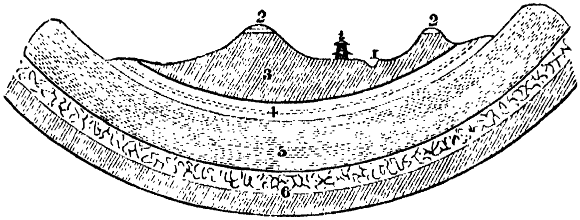
But as we are more than twenty miles from London, what have we to do with the geological peculiarities of that city, in the mazy streets of which this morning we lost ourselves, and which has now become a speck in the boundary of the distant landscape? Here, good reader, you are on the outer edge of the basin, in the centre of which London has taken up her seat. That the accumulation of strata adapted for building purposes has direct relation to the sites of cities, is evident in the fact that London, Paris, Vienna, and several other cities of less importance, are built upon basins of the tertiary. These basins are vast depressions, that were once estuaries or inland lakes; the depressions have been filled in by the deposit of earthy matters from the waters of the lakes. These deposits constitute the subsoil of London, and they are placed in such regular order of superposition, and so strictly concave in outline, that, within a circuit of

near a hundred miles diameter, the geologist can predict what particular strata will be met with at any given depth by boring or excavating.

The strata were deposited in the order in which we now find them by the successive action of the sea and of floods from the higher lands, and the basin was formed subsequently. If a ready method of preparing a model of the strata were required, it might be had by using a few layers of plaster of Paris, variously coloured, and poured successively one upon the other into a shallow earthenware bowl; or, more simple still—and we recommend the plan to be adopted by schoolmasters in giving lessons on the geology of London—roll out a quantity of dough, colour one portion with turmeric, and lay it at the bottom of the bowl, and there you have the lowest bed, which consists of sand and gault clay. Then lay over that a very thick layer of paste, without colour, and you have the great bed of chalk. Then lay on a thin stratum of paste, coloured with yellow ochre, and you have the bed of clay and sand which lies over the chalk. Lastly, mix up a lump of dough with plenty of umber for colouring, and instead of laying it in a regular stratum, work it in a conical form in the centre, so as to make a miniature mountain in the centre of the basin. Send your inverted geological pie to the bakehouse, and when it comes home turn it out of the vessel and cut it into two equal parts, as if you and a friend were going to eat it between you. Then you have a tolerably good model of the London basin in vertical section, and, in every one of your journeys out of town, the lessons derived from it will be useful as keys to the scenery of the country which surrounds London. The model will teach this lesson, that proceeding from the centre by any radius towards the circumference, the strata come to the surface successively; first we come upon the London clay, then upon the plastic clay and sand, and then upon the chalk, and lastly upon the green sand, and where any one of these is found to constitute the surface soil, it is said to "crop out," and it is this cropping out that causes the diversity of surface soils in the country immediately surrounding the metropolis. Suppose we go northward, then we shall find the London clay to be within a few feet of the surface at Stoke Newington, where the rain-fall will not pass through it. At Clay Hill, and about Enfield and Tottenham, the London clay is on the surface. If we go eastward, say, for instance, along the valley of the Thames, we pass first through the London clay, which is the proper soil of the pool, then through the plastic clay and sand, and at last the chalk peeps out upon us, and we know we are reaching the outer rim of the great basin. You have only to remember that while the clay is almost impervious to water, the sand and chalk which crop out in the high lands of Surrey, Essex, Middlesex, and Kent are capable of absorbing all that falls, and wherever we choose to pierce down to the chalk there we meet with it, the product of rainfall on the sands of Hampstead and Bagshot, within the basin, and the chalk of the North Downs, and the hills of Wiltshire, Oxfordshire, Berkshire, and Hertfordshire, which constitute the extreme edge of the basin. It is a simple matter enough to drink off a glass of water drawn from an artesian well, bored to the chalk, at such a place as the office of the *Morning Herald*, or at some of the great breweries, and then to make acquaintance with the very same strata exposed to the daylight, and with the water bubbling from it inexhaustibly, by entering the chalk-pit of Messrs. Meeson, at Grays, in Essex.

By the annexed section of the London basin it will easily be seen how, on leaving the metropolis, we successively come upon the outcrops of the various strata constituting the London basin. Draw a perpendicular line with a lead pencil through the strata at the point where the Thames intersects the

basin (1), and you have a vertical section of the strata at Grays Thurrock. The gault forms the outer rim of the basin, and next within that is the chalk; so if Mr. Meeson could succeed in conquering those remarkable springs—a consummation not to be hoped for—he would continue the excavations downwards until the gault was reached, and thus remove the chalk to its utmost depth. This chalk-bed is of great extent; it crops out in Wiltshire, Oxfordshire, Berkshire, and Hertfordshire. Over the chalk is the plastic clay or marine sands. At Grays, as we have seen, it is capped with sand, over a large extent of surface; indeed, plastic clay frequently alternates with beds of sand and shingle, as if, at the time of the deposit over the chalk, the delta of the Thames was a series of lagoons, in some of which aluminous, and in others siliceous, deposits occurred. The uniformity of the chalk points to a period of immense duration and of little disturbance, during which it was slowly accumulated in the vast depression occupied throughout its whole extent by the sea. Mr. Prestwich estimates the extent of the chalk in which the Grays Thurrock excavations are made, at ten square miles, and as at that measurement insufficient to account for a spring of water furnishing over two million gallons per diem. He looks for the origin of the source to larger receiving grounds, and he finds one to the northward, thirty miles away, where the chalk rises to the surface beyond Bishop Stortford, and forms an area of several hundred square miles of exposed surface. This tract is separated from Grays by an intervening mass of London clay, and under that bed of clay the water must flow for a distance of thirty miles, before finding egress in the fissures of the chalk at Grays. The depth of this bed of clay is nowhere more than 450 feet in thickness, and the dip of the chalk beneath this is, in some parts of the supposed course of the subterranean water-flow, 200 to 250 feet below the level of the spring at Grays. Another receiving ground from which the Grays springs may be derived, is that formed by the extensive area of the North Downs and chalk district of Kent, from which the rain-fall would percolate to a low level, and pass under the Thames, in its own laminated chalky bed, at a depth of about 80 feet below the Thames high-water mark. Mr. Prestwich thinks this Kentish area of chalk is the real head of the springs at Grays; but it is quite possible that both contribute, and that the whole mass of chalk in Hertford, Essex, and Kent is connected by subterranean arteries, gorged with water of meteoric origin.



THE LONDON BASIN.

1, River Thames; 2, Marine sands; 3, London clay; 4, Plastic clay; 5, Chalk with flints; 6, Green sand and Gault.

We have not space now to enter upon other equally interesting details which an investigation of these chalk-pits would lead to. Suffice it to mention, as a proof that the subject has but been touched on, that there is here a famous "elephant bed," in which are found remains of numerous mammalia of the tertiary. These, of course, lie

above the chalk, which is rich in marine remains of radiata and mollusca. To the casual visitor the flints alone would furnish a sufficiency of subjects for observation; and their regular disposition in horizontal beds, as exposed to view by the work of excavation, indicates clearly enough the successive deposit of the whole mass, layer upon layer, on a slowly rising sea bottom. By a bold assault upon this architecture of centuries, in which infinitesimal forms of life were the active workers under God, the Great Architect, man reaches the inner vaults of a mausoleum where vast successions of once living forms lie in the silent sepulchre. In so doing he obtains wondrous glimpses of the economy of the world in ages that lie far away in the dim past; though his primary object is to break down the portals of the tomb, and "grind the bones to make his bread."

SHIRLEY HIBBERD.

ARTIFICIAL LIGHT, AND ITS APPLICATION TO PHOTOGRAPHY.

It is interesting to look back upon the time long past, when the means of obtaining artificial illumination were comparatively unknown, and then to turn to the present period, and trace the progress science has made in this respect. The oil-lamp and rude tallow-urn of the ancients have given place to the unpretending "moderator," in our dwellings, and gas now lights those streets which it was once dangerous to traverse without a torch in one hand and a sword in the other.

The gloom of darkness is now dispelled, the terrors of the night have vanished, and science has given us comfort and security. The rich may call it a luxury, the poor may claim it as a necessary, but take from either the means of artificial illumination, and their energies would be crippled, their intellect impoverished, their time lost, their industrial occupations hindered, and the very safety of the community endangered, and the wealth and commerce of nations affected.

These considerations endow our subject with an interest of no ordinary character, and we may truly say that few inquiries would furnish so profitable a result as a complete history of domestic illumination, tracing its gradual development from the clumsy contrivances of former ages up to the productions of modern times, satisfying the demands both of taste and science. In such a narrative might also be shown the progress of light in the literal signification of the word; the advantages which science has derived by the study of this subject; and also the improved social condition of mankind. Among other minor matters worthy of note would be an historical account of many of the fanciful hypotheses and highly poetical conceits in respect of the nature of fire, which have at the various times occupied the attention of man.

Candles were used in the earliest days of Roman history, and it is curious to think that in Otaheite the candle was made by fastening a row of the kernels of nuts upon a skewer. Subsequently, mankind learned that the use of the resinous exudations of trees, the fat of animals, the bitumen and naphthas of the mineral kingdom, were not only combustible, but highly luminous. Having learnt this fact, it required but little ingenuity to suggest the use of some porous material, upon which the combustible might be smeared or into which it might be dipped before it was burnt. In this way the torch, the candle, and the lamp, were doubtless invented.

During the middle ages wax was extensively employed for the purposes of illumi-

nation, but the candles were not made by regular craftsmen, but by monks and servants. King Alfred directed how his candles were to be formed. "He commanded his chaplain to supply wax in sufficient quantity, and he caused it to be weighed in such a manner that when there was so much of it as would equal the weight of seventy-two pence he caused the chaplain to make six candles thereof, each of equal length, so that each candle might have twelve divisions marked across it." These candles when burnt in succession lasted twenty-four hours, and each division indicated the third of an hour. At first candles were only used in churches or monasteries or the houses of the nobility, but in the fifteenth century the employment of candles had become universal, and the trade of making them became so general that the chandlers of London obtained an act of incorporation.

This was the condition of things until a very modern period, when M. Argand, of Geneva, effected a complete change in the art of illumination. Every one is acquainted with the lamp that bears his name, the principle of which is, that the oil burns at a high temperature with a plentiful supply of atmospheric air. This is accomplished by means of a hollow cylindrical wick, and a glass chimney which surrounds the flame, which, by being thus inclosed, creates a greater draught of air.

In very recent times the greatest of all improvements has been effected by the use of gas, and those who can remember the old-fashioned lamp, with its miserable glimmer, and the dangers which constantly beset the traveller after nightfall, will have no hesitation in saying that the employment of gas for illuminating purposes has been one of the most important events of modern times. In truth, it has not only been the means of effecting a wonderful change in the whole system of artificial illumination, but it has also produced an equally important change in the domestic concerns of the people; it has encouraged industry, developed the arts, protected property, diminished crime, and operated in a thousand ways as a medium of wealth, prosperity, and social improvement. The first individual who turned his attention to gas-illumination in a practical form was a William Murdoch, of Truro in Cornwall. He distilled coal in iron retorts, and in 1790 lighted his house and offices with gas. He carried it about with him in bags, to serve as a lantern in travelling to and fro between the mines and his own house. He is said to have astonished the country people, who thought him a wizard. In 1798 he was exhibiting his experiments on artificial lighting at his manufactory in Soho, and at the Peace of Amiens, in 1802, a part of his manufactory was lighted with gas, and this was probably the first public exhibition of the new method of lighting.

It is curious to contemplate the present applications of gas and also of steam; the latter, although being in itself the greatest antagonist and extinguisher of flame, is composed of the most inflammable substances. Could these things have been known in the days of ancient Greece, poetry would have strung its harp, and the grandest epic productions of genius might have commemorated the victory of man over the inanimate matter of Nature, instead of dedicating her loftiest songs to the art of war.

Artificial light is due, in almost every instance, to chemical action. In proof of this it may be mentioned that the chemist is enabled to ascertain the exact composition of an organic substance by simply collecting and weighing the products of its combustion. The inflammable substances which evolve light and heat during their chemical union are generally distinguished by the terms combustible and supporter—the former term being applied to the body which burns, and the latter to that which permits of its burning.

We cannot here enter at length into the

theory of combustion; it is sufficient to state that chemists differed, but the results taught us that the progress of human knowledge is often dependent not so much on the discovery of great and important truths as on the manner in which they are contemplated; and if men's minds are not prepared for the reception of those truths they will either be disregarded or else made the means of propagating error. History tells us that discoveries, the main facts of which were broadly set forth, were disvalued because chemists were infatuated or led astray by false doctrines, and thus they allowed important truths to lie dormant and unnoticed. Even in the present day we find, in a less degree, the same influence possessing the minds of scientific men, and it is by no means uncommon to notice the difficulty which exists in inducing them to give their countenance and support to any new idea which has not been so thoroughly brought to bear, in a commercial point of view, as to compel them no longer to forego their decision in its favour.

The combustion of any substance may take place by slow oxydation, when little or no light is evolved; by a more rapid combination, when the burning becomes luminous; and by a still more energetic action, when it bursts into flame. An example of the first may be given in the luminosity of decayed wood or animal matter; both heat and light are evolved, though more slowly, still in an equal quantity to the most rapid consumption of the same substances. The second mode of combustion is when hydrogen gas or other vapour is mixed with air, and brought under the influence of spongy platinum. If the platinum does not of itself ignite the vapour acting upon it, the vapour or gas may be lighted, and when the platinum is hot the flame may be blown out, but the vapour will still keep the platinum in a glow though the gas may not be inflamed.

The third kind of combustion is when any vaporous matter has applied to it a sufficient degree of heat to inflame it. Some substances, such as phosphorus and phosphuretted hydrogen, take fire at ordinary temperatures, others require to be lighted; but in each case they continue to burn at a very exalted temperature.

Different combustible substances burn with different degrees of intensity, and this is wholly dependent on the number of solid particles that are ignited within the flame. When sulphur is burnt in oxygen gas it emits a faint blue spectral light, but when phosphorus is so treated it gives out a volume of light that the eye can hardly bear; the first being wanting in solid particles, the second being made up of myriads of white flakes of solid phosphoric acid. If we sift a little magnesia into a jet of hydrogen, which in itself gives but a faint light, its illuminating power is at once increased, and the same thing happens if we employ lime, oxide of zinc, or white antimony. So if we naphthalize the gas by passing it through ether, turpentine, benzole, or coal-naphtha, its light is at once increased to that of the best description of coal-gas. When the flame of the mixed oxygen and hydrogen gases is seen without impinging on any solid substance, it appears insignificant and almost invisible; but directly it is thrown on a piece of lime, or other material that will give it solid particles, it instantly becomes one of the most splendid lights with which we are acquainted; its intensity being such that it has been seen at a distance of upwards of 90 miles. So it is with the electric-light, the brilliancy of which is dependent on the number of particles of charcoal that are intensely heated by the galvanic current. The oxyhydrogen, or lime-light, has, however, great advantages over the electric-light in steadiness, continuity, and cheapness. The electric current can never be depended upon; it requires a large and powerful battery, which continually wants replenishing, and its cost is about £2 per night; while the lime-light, with all its other

advantages, costs only from a halfpenny to sixpence per hour, according to the quantity of gases consumed. Moreover, the expense of the battery and apparatus for the electric-light are enormous, while a simple lamp and gas-bags are all that are required for the lime-light.

Turning from the contemplation of artificial light, as known in former days, to the present brilliant methods of illuminating our dwellings, we cannot help noticing the gigantic strides that science has made. It is here, however, my object to endeavour only to describe those means of artificial lighting which may be used with advantage in photography. Among these, the lime-light stands pre-eminent. As in a previous article this light has been fully explained, I need not further refer to it, excepting as regards its application to photography. It may be used with, or without, the assistance of a condensing lens, or a reflector. The former being either the patent pressed lens, made by Messrs. Chance, of Birmingham, or the ordinary plano-convex lens of the magic-lantern; the latter being either a silvered material having a plane surface, or what is termed a parabolic reflector, which is somewhat similar in shape to a common wash-hand basin, having the bottom of it rather pointed; there are two apertures within a couple of inches from what I have termed the bottom, for the admission of the lamp; the light faces inwards. It throws the rays in parallel lines, provided the light is placed in the true focus, and the shadow caused by the lamp ceases to exist at a distance of a few feet, depending on focus and diameter. If the lens is used, it should be of clear glass, and colourless, or imperfections will be magnified, and the chemical rays intercepted. The naked lime-light, having a medium of finely-ground glass between it and a glass negative, to be copied in the camera, should be placed directly behind such negative. The sensitive plate will not require a more lengthened exposure than it would do were reflected sunlight used. For copying opaque objects, the condensing lens, or reflector, or both, must be used, to throw a strong light upon the object to be copied; the exposure will be a little longer than with reflected sunlight, and twice as long as direct sunshine. The light must in each case be brought as near to the object as practicable. For portraiture, a reflector must be used. The exposure required is much greater than with diffused daylight. For printing by superposition, its action is nearly instantaneous from a glass negative upon glass; but upon paper its action is more prolonged than with diffused daylight, though the result is by no means a weak picture.

The oxycalcium light is another form of lime-light, and may be used with nearly equal advantage. It is produced by passing a jet of oxygen through the flame of a lamp burning spirits of wine, or naphtha, or through a jet of hydrogen, mixed with common air. This mixture of air with hydrogen is accomplished by having a brass or porcelain burner, about four inches long, with an aperture at one end of about half an inch; near the other end the sides of the burner are open for the admission of the air; the tube from which the gas is ejected is in the centre of the burner; near these apertures it is about an eighth of an inch in diameter, and pinched rather closely together at the orifice; the gas does not take fire at this point, but passes up the burner, taking the surrounding air with it, and being lighted at the wide end, burns with a hot, blue flame, perfectly devoid of smoke or illuminating power. The jet of oxygen is made to pass, at a right angle, through either this flame or the flame of the spirit-lamp, and impinges upon the surface of a piece of lime, which it speedily renders incandescent, and of a brilliant white.

The expense of the spirit-lamp, or of the gas-jet, makes it obvious, however, that no advantage in point of cheapness exists in this form of lime-light over the one where the

gases are made to combine at the point of, and prior to, combustion.

Another mode of artificial lighting is one already alluded to, namely, the electric-light. This is produced by bringing a powerful galvanic action from a battery consisting of about 50 cells, of what is called "Groves' Battery," upon two carbon electrodes. The original cost of these batteries is great, and the expense of the acids, which must always be fresh, is also great. Moreover the fumes from the acids are highly noxious. A great difficulty exists in keeping the carbon points, or electrodes, at the proper distance from each other, and in keeping them pointed. The light is always liable to disappear in a second, not only from this cause, but from some unknown failing in the power of the battery, which has often puzzled our electricians to account for. Professor Way has improved upon the charcoal electrodes, by substituting a thin thread-like column of mercury, which he causes to continue flowing from a reservoir above to another beneath, and when the upper one is empty their position is reversed, as with the ordinary egg-glass, and when the upper part is refilled the light may be continued. This thread of mercury falls upon a small cup, which also contains mercury. The whole is inclosed in a hermetically sealed glass tube, similar in size to the ordinary argand chimney. The first action of the light is to cover the interior of the glass with condensed particles of mercury, which render the light invisible. As the heat increases these fall down into the reservoir below, and the glass becomes clear. It frequently happens that at this instant the glass cracks from a draught of cold air coming in contact with its exterior, or from some other cause; the consequence is, that the apartment is instantly filled with the fumes of mercury which escape. This, of course, is most dangerous. Then, again, the light emitted, though the most intense and photographically actinic artificial light known, is of a tremulous or intermittent character, most painful to look upon.

Another kind of artificial light used for photographic purposes, is one patented by Moule. It is produced by burning, in an inclosed receptacle, a quantity of powder, similar to that used for signal lights, and called "blue lights." Its colour is not, however, blue, but intensely white, and, next to the electric-light, it should I think take rank, as possessing actinic properties. One of its components being arsenic, renders it necessary to avoid inhaling any fumes arising from its combustion. When filled lightly into a zinc tube and ignited, it is intensely brilliant, and so hot as to melt and destroy the zinc as it burns. A portrait may be taken by it with an exposure of about twice or three times that of diffused daylight, and a piece of blue stained glass may with advantage be placed between the light and the sitter. There is, however, an insuperable objection to this light, from the fact that the resulting picture perpetuates an unpleasant stare, for the following reason: the sitter is focussed by gas or other light; perhaps, to get this correctly, it is necessary to bring the light close to his face, and trust to chance for the rest; he is told to sit steady, and the powder or composition is lighted; then he is so suddenly overpowered by the great contrast of light, that it is by no means wonderful if his most intimate friends fail to trace a resemblance between the portrait and the original.

The lime-light appears, after all has been said, to be the only real friend of the photographer, in an artificial point of view. It is completely under his control, and will no doubt shortly be brought before the notice of the public in an extremely inexpensive form. The age of discovery is said still to be in its infancy, and as regards artificial lighting, this has, I think, been plainly deduced in the foregoing article.

S. S. Baxter.

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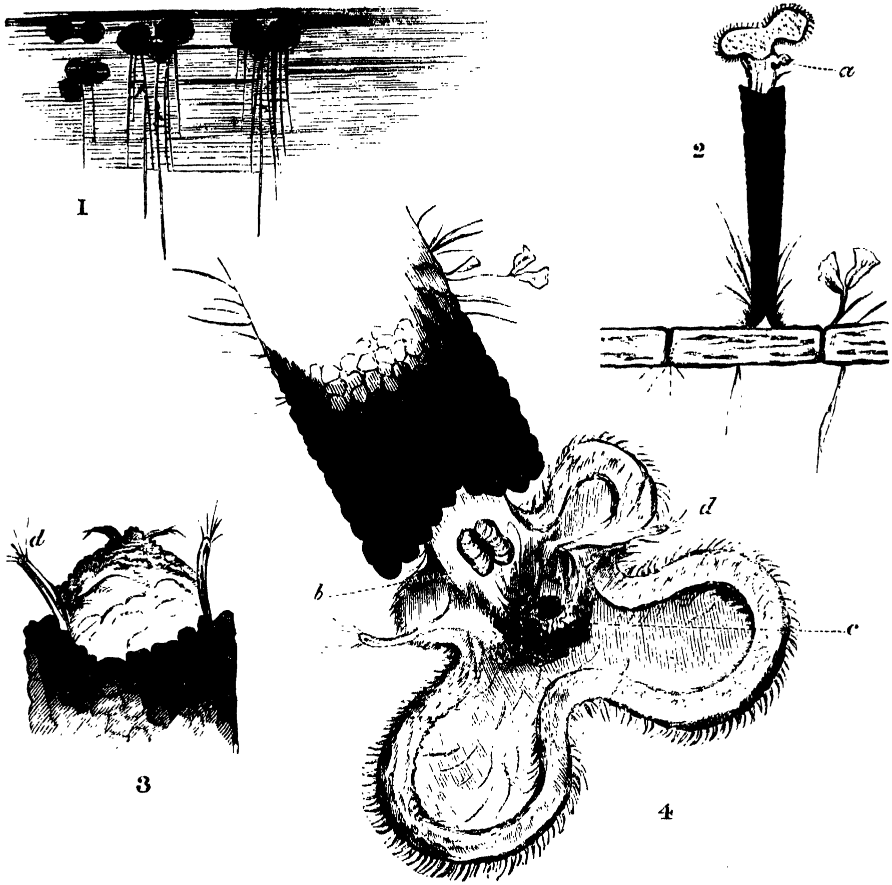


Fig. 1, Natural size attached to Lemna. Fig. 2, Magnified about thirty diameters, attached to Confervæ, and showing position of smaller ciliary process at *a*. Figs. 3 and 4, Magnified about 120 diameters, showing jaws at *b*, and at *c* the pellet in course of formation; *d*, tentacular processes.

MELICERTA RINGENS.

During the last and the present season this beautiful animalcule has been found, in the fresh-water aquarium, attached to many different plants, including the new water-weed or water-thyme (*Anacharis alsinastrum*), the water-violet (*Hottonia palustris*), the water-soldier (*Stratiotes aloïdes*), lemnas, confervæ, and some others; but, although growing in the same tank, it has not been seen upon the *Vallisneria*, the *Potamogeton densus*, or the frogbit (*Hydrocharis*). The appearance of the animal to the unassisted eye is shown in Fig. 1, as attached to lemna, and in Fig. 2, as upon confervæ, slightly magnified. The head is usually pointed downwards, and the base always fixed to the under side of the

leaf. It may easily be mistaken for a piece of dead plant; but, when placed under the microscope, it will be seen that the dull brown-looking object is a cylindrical case of symmetrical form. The case being so pretty, let us wait for a sight of its shy little tenant. It is easily frightened; we must not tap on the table or microscope stand, or walk heavily across the room, or it will hide itself; a Cyclops, Daphne, or other large animalcule, coming near, will startle it. A little patience however, and we shall be rewarded; unless, indeed, we have happened to select an empty case, not at all an unfrequent occurrence. There it is! First we see a small white head protrude, apparently to ascertain if all be safe; then comes a large gelatinous-looking mass (as in Fig. 3), which gradually unfolds, forming one of the most wonderful and extraordinary sights which the microscope can reveal. This is attempted to be shown in Fig. 4, but owing to the extremely varied movements of the animalcule, it is difficult to sketch. It will be seen that, when fully expanded, there are four lobes fringed with cilia, which give the appearance of wheels of unequal size running together; or, perhaps more correctly, of a band or ribbon with teeth moving in waving lines. Near the larger lobes will be seen a small ciliary process, the use of which appears to be connected with the construction of the case, as immediately below is a small opening, in which sometimes may be seen the formation of the pellets of which the case is built; for the little creature is its own architect. Particles of matter are collected from the water, and, as soon as the bead is sufficiently dense, the body is bent forward, and the bead or pellet is attached instantly and firmly to the wall of the case. During the process of formation the pellet will be seen revolving, and, perhaps, at the same time becoming mixed with some kind of glutinous matter. To observe this requires close attention, but an hour spent in watching this interesting process will be amply repaid by the pleasure afforded to the observer. The time occupied to form each pellet varies according to the abundance of floating matter in the water. Two or three pellets may be formed in a few minutes, or it may occupy half an hour to form a single one; or, indeed, very much longer. This process of building will not be seen in every specimen, for, of three observed during the same evening, one only was thus occupied. The cases are slightly tapering in shape, and nearly uniform in diameter, having about the same number of pellets in the width, or, more correctly, in the circumference, and the length varies according to the age or the industry of the little artificer, the longest being about the sixteenth of an inch. The case *appears* to be formed of hexagonal beads, but this must arise from pressure, as the form of those recently attached is always circular. This minute animal is so interesting when fully expanded and at work—its motions are so wonderful—there is so much to admire and observe in it, with the water in its natural state, that we are unwilling to disturb it. But let us see what will occur if we mix a little colouring matter with the water. Having rubbed a small quantity of indigo or carmine as fine as possible on a slip of glass, the top of the live-box must be removed, and a drop of the coloured water put in, when it will at once spread. The cover of the box must now be replaced carefully, so as not to disturb the object it contains; and, after waiting a few minutes, it will be ready for our further observation. We become more interested than before, and we now see more distinctly the use of the cilia or hairs forming the revolving fringe. The floating matter in the water is drawn forward as the little hairs lash the fluid in rapid succession. A dark coloured rim is formed just within the line of the cilia, and, after making a complete circuit, the rejected portions pass off in a straight line, disperse, and are again drawn into the vortex; and this process is continued

until we are tired of watching. Some portions have passed into the jaws and stomach, others have been collected by the smaller ciliary process, and form pellets which now border the case, and, the matter being more dense, it is easier to watch their formation and use. We are still unwilling to disturb our pet, but its prettiness should not attract all our attention. The body is generally protruded so as to show the jaws or gizzard, and, with a magnifying power of 250 or 300 diameters (with oblique illumination, perhaps, with less power), the teeth may be seen, and occasionally the stomach and other internal parts. The writer, on a recent occasion, saw one which had left its case, owing to its having become detached in pressing down the top of the live-box, and it was curious to notice the extreme sensitiveness of the body. One of the common rotifers was in the water at the same time, and presently seized the lower part of the Melicerta running over it, very much apparently to the discomfort of the latter, for it writhed and twisted its tail as if suffering great pain, and did not recover during the time it was under observation. If carefully managed it may be made to leave its case by gently pressing the part where it is attached to the plant, and, if not injured, it will swim out, using the ciliary processes as propellers. There are many other points of interest deserving attention, but this notice is written chiefly for the purpose of directing attention to one of the most curious and interesting creatures to be found in water; and the writer would recommend those who have not seen it to examine all kinds of water-weed, and, when success has rewarded their efforts, he thinks he can promise them a greater microscopic treat than they have ever before enjoyed. A. B.

WAYSIDE WEEDS AND THEIR TEACHINGS.

HANDFUL V.

"Wondrous truths, and manifold as wondrous,
God hath written in those stars above,
But not less in the bright flowrets under us
Stands the revelation of his love."

LONGFELLOW.

It is but little in the way of bright colour or sweet scent we have to offer you in this our Fifth Handful, and therein lies a difficulty, as far as the plan of our lessons on "Wayside Weeds" is concerned; for, leaving those lessons upon wild flowers known to all, the inconspicuous and scentless plants are but little recognized by the inattentive passer-by. However, let us try, and do not turn away because we bid you gather unattractive weeds; they have only to be looked into and examined, to exhibit that beauty and perfection which are never wanting, even in what seem to man the lowest works of the Creator.

Begin with picking one of the common dock tribe, the usual, and certainly not handsome, representatives of vegetation which are found most commonly about building rubbish and on neglected ground; add to it one of the nettles which usually keep it company, and put alongside the nettle, if you can, its relative the common hop (Fig. 57), establishing what seems to you a strange relationship. Keeping still to our rubbish-heap, or searching any roadside, where weeding is neglected, and therefore truly a wayside weed, you gather an insignificant-looking little plant with stems so weak that they rest much on

the ground, and with numerous little pink blossoms (Fig. 80) fitting closely into the axils of the leaves. This, the common knot-grass, has a close family connection with the buckwheats, one of which, having the habits and leaves of a convolvulus, you have at Fig. 71. These knot-grass, bistort, and buckwheat weeds are near relatives of the docks, as you

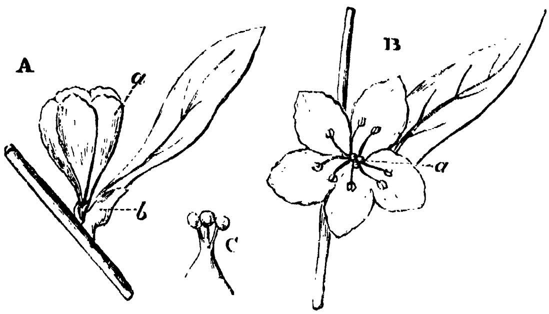


FIG. 80.—Blossoms magnified of Common Knot-grass. A, Side view; *a*, perianth; *b*, membranous bracts. B, Front view; *a*, triple styles. C, Styles much magnified.

will find out on examination; moreover, their little pink flowers are very pretty indeed when minutely looked into, and even without the magnifier give some amount of lively colour to our otherwise sombre handful, especially if we gather some of the larger-flowered bistort* species. For our next plant you probably need not go further than the first neglected garden where "weeds do grow," for there, or on some neglected bank outside the garden, the spurge or euphorbia family are most apt to take up their quarters. Every school-boy, who has applied their milky juice as a cure for his warts, knows the spurges (Fig. 81); they are curious in their flowering, and puzzling enough to an incipient botanist, but more of them presently. And now go to the runlet or any ditch of clear water, for a handful of these very bright green, floating, star-like leaves, the water starwort; you see no flowers, but never mind that, we shall find these for you presently.

It seems quite a jump from this little water-plant to the forest-trees, to the oak, the birch, the hazel, and the willow, such a jump that all connection seems wanting between these and the lowly weeds we have just been directing you to; nevertheless we

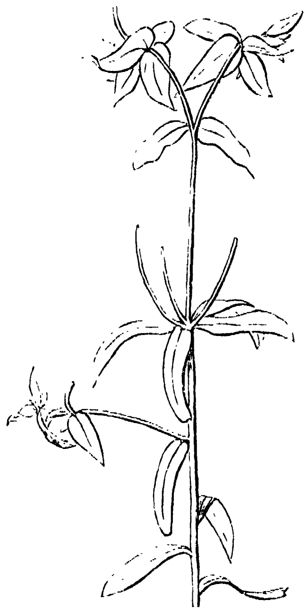


FIG. 81.—Petty Spurge. The blossoms arranged in umbels.

shall see, although, confessedly, we have brought together an apparently heterogeneous handful, and one not quite so attractive to a beginner as those we have already passed. The trees you must know well enough, even if you never thought of their having blossoms, but you must look for their flowering in spring and early summer.

But it is time we looked for that character in common which connects together plants so apparently diverse. We have, you are aware, hitherto found the flowers we examined, whether many-petaled, or one-pieced blossoms, perfect; that is to say, possessing

* The knot-grass, bistort, and buckwheat, all belong to the same botanical genus, *Polygonum*.

both calyx and corolla, the plants now in your hand are all marked by having incomplete flowers; the calyx and corolla seem merged into one, forming what is called the perianth, as in the knot-grass (Fig. 80), and in many of the division there is not even an attempt to develop what we usually consider a flower, but as in the hazel, the birch (Fig. 86), the willow, or the little starwort (Fig. 82), a simple scale is all that is left to represent the gay corollas and green flower-cups of our well-known blossoms. By some this division of flowering plants is called the Apetalous, or petal-wanting, in contradistinction to the Monopetalous and Polypetalous; by others the families are classed as the Monochlamydeæ, or those with but one floral covering. It is not, however, simplicity alone which we meet with in some of these flowers under notice, but, as in the spurges (Fig. 83), extreme peculiarity of structure.

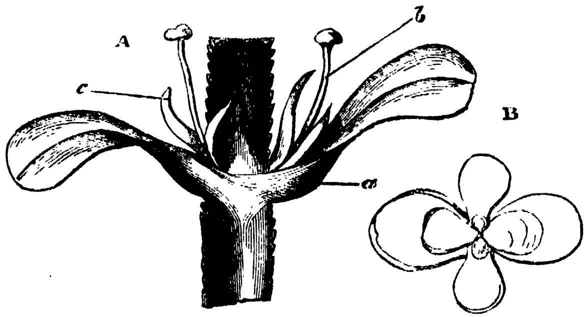


FIG. 82.—Magnified View of Barren or Staminiferous Blossoms of Common Starwort. A: *a*, leaf, partly embracing the stem; *b*, stamen with one-celled anther; *c*, scale which represents the perianth. B, anthers, showing star-like arrangement of leaves.

Now as the compass of our paper will not allow of a minute explanation of the structure of all the certainly dissimilar plants to which it has introduced you, let us take three, at first, as unlike as possible, the knot-grass and buckwheat (Fig. 80), as most resembling our ordinary notions of a flower; the spurge (Figs. 81, 83) as a specimen of the curious, and the starwort (Fig. 82) of the simple; for all three you will need your magnifier.

As to the first, the knot-grasses or buckwheats, you will find they have a perianth of five coloured segments (Fig. 80), doing duty for both calyx and corolla, though most resembling the latter, a definite number of stamens, and that the central ovary, at least in the common species we have pointed out to you, is crowned with three little knobs or styles; and if you examine further some of the blossoms which are more advanced, you will see that the ovary thus tipped has developed into a three-cornered little fruit, or, as a botanist would call it, achene. You remember we told you that the docks of the rubbish-heap were family connections of the buckwheats; examine both flower and fruit of the former, and you will find, with certain differences of course, how many points they have in common.

We turn to our friend with the milky juice, the dwarf spurge (Figs. 81, 83); not one of the umbel-bearers properly so called, although its blossoms are arranged in umbels, these same blossoms being very odd concerns. The illustration (Fig. 83) represents a single set of flowers of the dwarf spurge in two positions, and magnified of course. You observe a set of flowers, not a single flower, for that which seems to occupy the position of perianth is ranked as the involucre, containing several barren or stamen flowers (Fig. 83), and one fertile or pistil flower, which has its germen crowned with three forked or bifid styles, and is conspicuously extruded. In addition, however, to the stamens and pistils, the involucre contains a set of remarkable "horned glands;" the real perianth, which might be expected to lie within the

involucre, is scarcely, if at all, present, in the form of a minute scale.

The starwort, third in our group (Fig. 82), is the essence of simplicity; so much so, indeed, that you will find it almost as diffi-

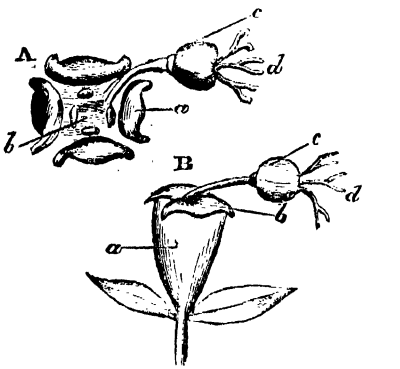


FIG. 83.—Magnified Blossoms of Petty Spurge. A, front view: *a*, glands of involucre; *b*, stamens; *c*, ovary; *d*, pistils. B, side view: *a*, involucre; *b*, glands; *c*, ovary; *d*, pistils.

cult to realize its flower, as you may have done in the singularity of the spurge blossom. If you examine with your magnifier the axils of the starwort leaves, which partly embrace the stem, you will soon discover, but not together, either the single stamen or the little ovary, with the two wee white bracts at its base, which is all this little bright plant has to boast of in the way of floral appendage; little enough, but yet the flower is a real flower, having its essential organs of reproduction, if not the organs calyx and corolla, which, as we have already explained in a former lesson, constitute a perfect flower.

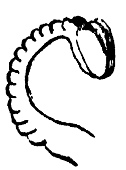


FIG. 84. Jointed elastic stamen of Wall Pellitory.

We might say much more of these insignificant flowers which go to make up our handful: of the nettle, which, common and despised as it is, has flowers which repay examination, and of the wall pellitory, too, a first cousin of the nettle, which finds root at the base of old dry walls; the situation, the general reddish tinge about it, its inconspicuous flowers, and its loosely hung leaves, will tell you the plant, and it is worth a few minutes' examination with the lens to make out the beautiful structure of the jointed filaments of its stamens (Fig. 84).

But we have kept these tall trees of the greenwood, mentioned before time, waiting so long, that we must not stay longer amid the weed class; real true weeds they are, most of them, but with a curious minute beauty of their own which well repays examination, but, having shown you the way, we leave you to work out your further acquaintance with the docks, the nettles, the goosefoots, and their congeners. And now for our trees. We give you our list, and you must pick out as many as you know, or as many as you can find. The birch, oak, alder, poplar, the numerous willows, the hazel, the elm, the beech, and the fir, and various others, all fall into our category, and are connected both with one another, and with the weeds of our handful already noticed, for, being dicotyledonous plants, they are destitute of the double and complete floral envelopes, such as we have hitherto been accustomed to. Some of our trees, such as the elm, have their flowers so far regular that they have both stamens and pistils in the same blossom, but in most the stamens and pistils are separated, either on the same or on different plants, and in many the flowers, such as they are, cluster together in what is called an amentum, or catkin, that is, a succession of little blossoms surrounding a stem, pendant or otherwise, each little blossom being composed of a scale with two or more stamens attached. Such little scale-formed blossoms we have in the case of the common willow, and the birch has a very similar arrangement. In the hazel, the catkin of male flowers, the "pussy-cat's tails" of our early days, are very conspicuous; but not so the pistil-bearing flowers, which indeed few know but those who have had a botanical introduction to

them, for the large stameniferous catkin, shaking out its showers of golden yellow pollen in early spring, quite eclipses the little bud-like fertile blossoms, which you will find not far from their more conspicuous mates, albeit you would scarcely distinguish them from buds, but for the protrusion from their extremities of a number of brilliant red filaments; these are the styles, and within the little bud lies the ovaries, which, in due time, become the clusters of autumn; the ovary expanding into the nut, and the scales of the bud into what people call the husk, but a botanist the involucre. The oak, too, has its barren and *deciduous*, or quickly-falling stameniferous catkins, but its fertile flowers are solitary within a cup-shaped scale, or rather aggregation of scales, which at length become the "acorn cups" of fairy lore.

Fig. 85.—Single Blossoms of Willow; *a*, pistil-bearing, or fertile blossom, with scale; *b*, stamen-bearing, or barren blossom, with scale.

Lastly, we have mentioned the fir. It, too, has its barren catkins, but the fruit, as all know, is in the fir cone, which generally we see when it has dropped seedless and dry from the tree; the ovules, the seeds, which lay naked at the base of the nerve in the dry cone, open scales, having disappeared, wings and all. The naked seeds of the firs or pines, that is, seeds without proper pistils, their many cotyledonary, or seed-leaves, in contradistinction to the two seed-leaves of the plants hitherto examined, place this pine tribe by themselves, even were there not other distinctive characters in leaf, wood, etc.; and these, however, are not for our beginners to enter into.

With the simple incomplete flowers of our woodland trees, we come to an end of the first great division of the vegetable kingdom, that which includes plants with two seed-lobes, or leaves, or cotyledons, hence named the dicotyledons, which have netted, veined leaves, and which also growing by the deposit of annual rings of wood on the outer circle of their stems, beneath the bark, have likewise the name of exogens. After our next lesson on stems and roots, we reach the second great division of plants, the monocotyledons or endogens, and get again amidst gay colours and handsome flowers.

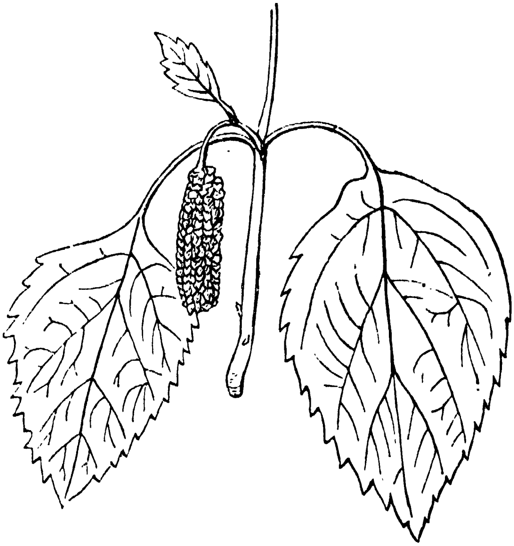


Fig. 86.—Catkin Blossom of Common Birch.

Spencer Thomson, M.D.

The Inquiries of Messrs. Sullivant and Wormley show that lines on Nobert's test-plate cannot be separated by the modern objective if closer together than $\frac{1}{87000}$th of an inch; Amphipleura pellucida has no true striæ; Diatoms of the same species are very uniform in their markings.

FRESH-WATER POLYPS.

THE fresh-water polyps exhibit one of the simplest and most elegant forms of animal life, and from the facility with which two of the commoner species can be procured, and their ability to live in confinement, their peculiarities are easily observed. To obtain a supply, all that is necessary is to collect a handful of duckweed and other water-plants, from still, clear ponds, or slow streams. The plants should be put in bottles of clean water, placed in a light situation, and if polyps are present they will be discovered, in the course of a few hours, adhering to the sides of the vessel, and slowly swinging their arms in search of prey. They may be found at all seasons, even under ice in a sharp winter, and should be associated with water-fleas (*Entomostraca*), or other small creatures, upon which they feed.

The fundamental idea of a fresh-water polyp is that of a gelatinous tube, capable of contraction, dilatation, and great change of shape, terminating in a mouth surrounded by tentacles, varying in number, according to the species and the individual, from six to twelve. A good-sized *Hydra* (*vulgaris* or *viridis*) measures, when expanded, about half an inch.

On the discovery of such a creature, it should be carefully removed, by means of the dipping-tube, to one of the glass cells described in page 311 of the first volume of this work, and viewed, with a low power, either as an opaque or transparent object. It will most probably be the common polyp (*Hydra vulgaris*), or the green polyp (*Hydra viridis*), of which descriptions are given by Dr. Deakin at page 3, vol. ii., and to which we refer the reader for the illustration of points not referred to in this paper.

To distinguish the species is not difficult. The first named will exhibit tints of orange-brown or yellowish-red, and the tentacles will be about the length of the body; the second is of a beautiful apple-green, with tentacles shorter than the body. There is also a brown hydra (*H. fusca*), less often found, and which is readily distinguished from the common polyp by the extreme prolongation of the tentacles, and also a rare green one (*H. attenuata*), with the body attenuated below, and the tentacles pale and larger than those of the green polyp.

On being placed in the cell, the polyp soon makes himself at home, fastens his tail to the glass, and stretches himself about in all directions, as shown in the annexed sketches, which represent the various shapes successively assumed by a *Hydra viridis* while under examination (Fig. 1). The ordinary

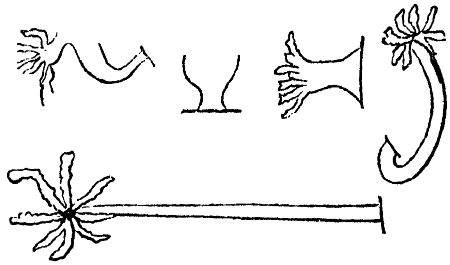


FIG. 1.—*Hydra viridis* in various shapes.

movements are those of lazy, graceful enjoyment; but if one of the feelers happens to touch any small animal suitable for food, a sudden development of energy is observed; the prey is strongly grasped by all the tentacles, and passed through the mouth to the stomach, where the process of digestion may be seen to go on.

The structure of polyps has been much discussed, and it is easy to fancy, as early observers did, that their bodies consist of two or three layers or coats. The prevailing

opinion, however, coincides with that of Ecker, that the animal is composed of the substance which Dujardin names *sarcode*, and which is an elementary form of the albuminoid material of which the higher animals are chiefly made up. The uniformity of the structure of polyps is shown by the readiness with which one part performs the functions of another, and by the slight inconvenience which the creatures experience from being cut in pieces. If turned inside out, that which was stomach makes a very good outside coat, and that which was outside coat digests its dinner as well as the original stomach. Each piece is capable of growing into a new polyp, and a portion of one may be successfully grafted into the body of another.

Thus, with the exception of the curious stinging organs—which we shall presently describe—the Hydra exhibits no localization of function in special structures, which is the characteristic of higher creatures; but its whole mass is alike capable of manifesting irritability and contractility, and of carrying on the process of digestion by secreting a kind of gastric juice, and absorbing and assimilating the solution that is formed. Many physiologists would deny to the polyp any kind of consciousness; but, notwithstanding their arguments, it is not unreasonable to believe that it derives, in a humble way, some pleasure from its possession of an elementary form of animal life. At any rate, its movements are readily associated with the idea of happiness, and they have more purpose in their appearance than those of the diatoms, or other acknowledged members of the vegetable world. An Italian philosopher imagined that they could "feel light;" and without accepting this phrase in a strictly scientific sense—in which it is certainly untrue—we may fancy that they have their share of pleasant sensations when sunshine illuminates the world.

Sometimes the polyps seem voracious, and at others they play with the creatures that come within range of their tentacles, without making any serious efforts to devour them. A curious scene of this kind was witnessed by the writer in February, with a specimen of the *Hydra viridis*, which was placed in a cell under the microscope, together with some small Entomostracans.*

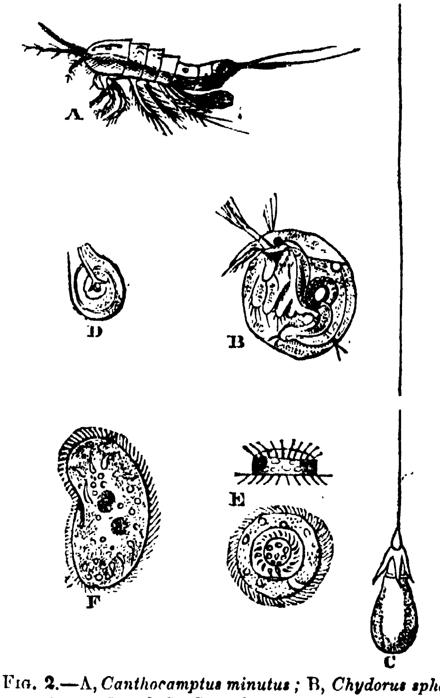


FIG. 2.—A, *Canthocamptus minutus*; B, *Chydorus sphæricus*; C and D, Capsules and poison-thread of polyp; E, *Trichodina pediculus*, side view and under view; F, *Kerona polyporum*.—*Microg. Dict.*

While leisurely swinging its feelers about, one of them came into contact with a lively little creature, *Canthocamptus minutus*, of which a sketch is appended (Fig. 2). The

* Entomostraca are small Crustacea, very various in form, and extremely common in ponds and ditches. Their shells are, for the most part, so transparent as to exhibit their internal structure, and the motions of a rudimentary heart. Their movements are easily observed in the glass-cell, but their structure is best shown in the live-box, taking care to press the cover down so as to confine without injuring them.

Canthocamptus—a female with eggs, carried in a club-shaped mass under the abdomen—seemed paralyzed, but the Hydra did not attempt to convey her to its mouth. After a little while a fellow-prisoner in the cell, a round, merry little Entomostracan, called *Chydorus sphæricus*, came to the rescue of Canthocamptus, tugging it lustily by the tail. This roused the latter to make some effort, and, with the aid of her friend Chydorus she speedily effected her escape. It would be easy from this incident to make a pretty story of the loves of the Entomostracans, but we have to do with facts only, and cannot affirm that we witnessed any passages of affection after the rescue had taken place.

If Canthocamptus had been a sensible creature, she would have acquired wisdom by experience; but far from this—she had scarcely regained her liberty, when she was caught again through bumping against the tentacles of her foe. This time she was voluntarily released by her captor, and, strange to say, her second adventure made no more impression than the first. When the polyp caught her for the third time, her last moments seemed to have arrived; but either her enemy was not hungry, or she was not the dainty dish that he desired, and after tossing her about in a playful manner from side to side, he permitted her to depart undigested and in peace.

The stinging organs of the Hydra bear a close resemblance to those which Mr. Gosse detected in the sea anemonies, and which are elaborately described in his work on those creatures. The best way to see them is to squeeze a small polyp, or the tentacles of a larger one, in a compressorium, or live-box, when a number of capsules, under a power of 400 or 500 diameters, will be readily seen, from which long and extremely fine threads are emitted.*

Some writers have denied the stinging function of these capsules and missile-threads or wires, but a perusal of the facts and reasons adduced by Mr. Gosse, in the work just mentioned, leaves no doubt on the subject, so far as regards anemonies and medusæ, and makes the case of the polyp much more clear.

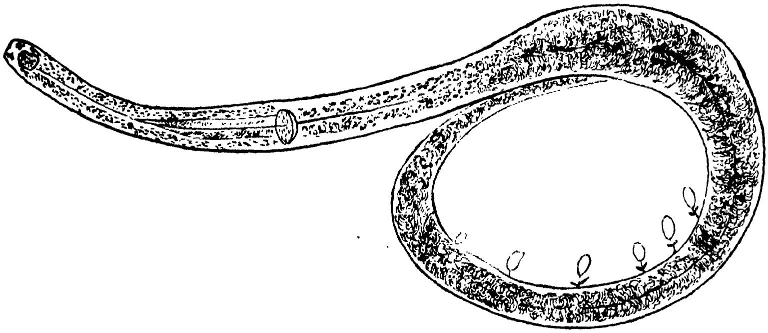


FIG. 3.—Anguillula pierced by stinging organs of the *Hydra viridis*.

The sketches (Fig. 2, C and D) show the polyp capsules with the spines and missile filament protruded, and also with the spines and filament inclosed and at rest. The authors of the "Micrographic Dictionary" consider that when the filament is in the

* The beginner may be reminded, that as these threads are exceedingly slender and transparent, they require careful illumination. A strong blaze of direct light renders them invisible.

capsule, the spines are directed forward and in close contact, and that by suddenly jerking backward and reversing their position, the filament is thrown out. They confess, however, that they have not been able to witness the process, nor have we been more successful; but we were fortunate in finding a small worm, very common in pond-water, pierced with the weapons to the very hilt. The worm in question is shown in Fig. 3. It was attached to the tentacles of a *Hydra viridis*, and when released by pressure of the live-box, was found as represented, and to all appearance dead.

It is possible that the spines may serve some purpose in the ejection of the filaments; but they can scarcely do all the work, and Mr. Gosse thought he discovered evidence that the equally slender stinging threads of the anemonies are hollow tubes, which, when at rest, are *inverted* like the finger of a glove turned outside in, and are thrust out by the pressure of a suddenly injected fluid. But, whatever may be the precise mode by which the weapons are darted forth, they possess considerable powers of penetration, and the injury they produce cannot be accounted for upon mechanical principles; they evidently convey a poison into the wound, but concerning its nature little or nothing is known.

The Hydra population is maintained by two processes: the formation of a kind of egg in the substance of the lower part of the body, and still more commonly by the growth of a young polyp like a branch from an old one.

Fig. 4 represents a *Hydra viridis* with a baby almost as large as itself, and also with a small knob or bud in process of development into a similar offspring. After a time the young polyps separate from the maternal establishment, and set up housekeeping for themselves.

If the polyps are allowed to get sick through impurity of the water, they become infested with parasitic infusoria, the *Kerona polyporum* and the *Trichodina pediculus* (Fig. 2, E and F), and, as the authors of the "Micrographic Dictionary" observe, "it is curious to see these creatures running about the tentacles, and neither afraid of nor injured

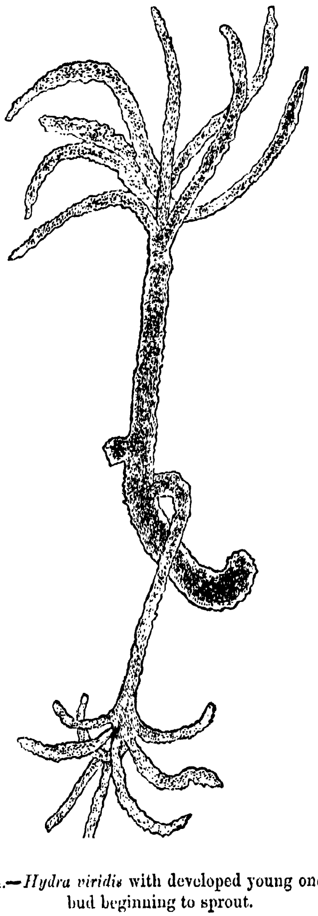


FIG. 4.—*Hydra viridis* with developed young one, and bud beginning to sprout.

by the formidable weapons with which those organs are armed, from which it would appear that they have a friendly office to perform."

HENRY J. SLACK, F.G.S.

THE LABOUR OF THE SUNBEAMS.

To an intelligent mind there are few objects more suggestive of thought than a *vivarium.* It is a little world in which we can study the processes which keep the life of the great world alive. Take, for example, a fresh-water vivarium. Disporting themselves in the water are fish of varied hue and symmetry; water-snails crawl lazily over the sides and miniature rocks beneath, and growing vigorously from the mud and sand at the bottom, is the pretty *Vallisneria spiralis*, sending out its long thin leaves through the vessel. The social economy of the little world is this: The snails live on the decayed leaves; the fishes live on the young of the snails; and both disengage oxygen from the water and give off carbonic acid—a compound of oxygen and carbon, the staple of their food. The water would, therefore, soon be deprived of its oxygen, and impregnated with a gas obnoxious to life; but watch the leaves of the Vallisneria, especially on a bright sunny day, and you will see minute bubbles of oxygen passing of from every pore; the plant is aerating the water, and feeding itself on the carbon. The oxygen goes direct to the gills of the fish, the carbon returns indirectly to its stomach in the form of the young of the snail. Such are the links in the golden chain, the "wheels within wheels," which maintain the magnificent progress of the chariot of life.

Animal life was compared to a flame long before the discoveries of science proved that this was no mere poetic fancy. There is a process of combustion advancing within us; our food is the fuel, and our breath the draught, which nourishes the flame. Left to itself life burns low, and ultimately dies out. Regularly replenished and constantly tended, it supplies those vital energies which distinguish the animal from the vegetable. A scanty or inappropriate diet produces weakness, a generous abundant diet produces strength. Life, therefore, is rather a dispenser than a producer of force—the great steward of energies drawn from without. When we move a leg or an arm we use only the common mechanical arrangement of bands and pulleys, by which we would communicate a similar motion to a piece of dead matter; and, as we can trace the motion of the straps and wheels of a factory to the chemical action going on in the furnace beneath the boiler, so we can see the origin of the force which moves the bands and pulleys of the animal machine, in the chemical action to which the food is subjected.* Now, since a substance which has been burned cannot be burned again, it follows that, without some regenerative process, animal food would all be de-energized, all vital chemical force would be exhausted; there would be nothing to eat. All the carbon, hydrogen, and other elements, would be already in combination; their energy transformed partly to heat, partly to electricity, partly to work done, pyramids raised, cities built, railways and roads made, and other remains of the handicraft of a race exterminated for want of sustenance. We have described the beautiful device by which such a catastrophe is averted—the wondrous cycle of animal and vegetable life: the vegetable fixed and passive, the animal locomotive and active; the vegetable *un*burning, the animal burning; the vegetable producing, the animal consuming, organic substances. Nor is the growth of the forest-tree essentially different from that of the esculent which is eaten by

* See article *Vital Dynamics*, by the writer in "Nicholl's Cyclopædia of the Physical Sciences."

man and other animals. Whether it be "the tallest pine," to which Milton likens the spear of Satan,

> "Hewn on Norwegian hills to be the mast
> Of some great Ammiral,"

or the herbs cropped by the browsing herd, the great bulk of their substance, and certainly all but a fraction of what is available for food or fuel, is obtained by decomposition of the products of combustion imbibed from earth and air. Let us get a clear idea of the nature of this decomposition. Suppose two particles, say of oxygen and carbon, lying side by side, and kept there by an attractive affinity. Suppose they are pulled asunder against this attraction, and then left free to fly together again, and give up the energy of their impingement as heat. It is evident that force must be expended in pulling the particles asunder; and that it must equal the force with which they again collapse. Such is the process which we have called *un*burning. The energy of carbon, hydrogen, and oxygen is returned; or, in other words, energy has been spent in separating these elements. Energy of what?

We have seen the leaves of the Vallisneria giving off their bubbles of oxygen in the sunlight. This is the process of *vegetable respiration*, the reverse of animal, proved by the experiments of Priestly, Ingenhouz, Saussure, and others, to be dependent on light. A plant does not commence this process until it reaches above ground. Its activity ebbs with the departing light, and flows with the returning day. All through the day chlorophyll, the colouring matter of plants, is being deposited, and woody tissue compacted, while oxygen flows off into the air. Night brings repose to the vegetable as well as to the animal world. No tissue is formed, no oxygen is given off, no carbonic acid is absorbed from the air, and that which is imbibed by the roots passes off from the leaves unchanged. Sunlight is, then, the chief agent in vegetation. What is sunlight? It is a mechanical state of the circumambient atmosphere—a propagation from the perennial light-spring in the sun of inconceivably minute wavelets. Sunlight has long been known to possess three properties—an illuminating, a heating, and a chemical. If we catch a beam of light upon a prism, it will be found to resolve itself into elements, in each of which all these properties are found in some degree; but in each, one predominates so far over the other two, that we speak of the light-giving, the heating, and the actinic or chemical rays. Still all are mechanical states of matter, and their several effects are energetic, the effects of force, and subject to the established laws of force. The period of vibration of the wavelets, or the number per second, determines the nature of the effect; the heating power increases, and the chemical power diminishes as the period of vibration becomes longer, and the gradation in period between the two extremes determines the colour, from red the longest, to violet the shortest. Whatever physical change is produced by a body in motion, in virtue of its motion, is produced at the expense of that motion. Whatever, therefore, the manner in which sunlight acts, it ceases to exist as sunlight, and assumes some other form; that of the physical change effected. It may be vibratory motion in the retina of the eye, the "shivering motion called heat," in bodies animate and inanimate, energy restored to decomposed chemical elements, or any of the many changes, direct and indirect, wrought by this wondrous agent in the universe. When we decompose water, *i.e.*, separate oxygen and hydrogen by force of electricity, we exchange electric power for the tendency of the gases to unite, or their affinity, and this tendency is satisfied by applying a light to the gaseous mixture. An explosion ensues. We get water as before; but, besides, heat, the equivalent of this affinity, or, what is the same, of the electricity. So the force of the small fraction of the in-

finitesimal light-wavelets, which originate in the sun, is made latent in the affinities of oxygen, hydrogen, and carbon, separated in the leaves of plants. When these reunite, in the consumption of fuel or food, we get carbonic acid and water as before; but, besides, heat, or electric or muscular force, the equivalent of the light-power expended. Only a small portion of the solar rays ever reach this earth, and, of that small portion, a mere fraction is thus economized.

It is evident that if we could discover how much heat the vegetation on a certain space of land would yield when burned, and how much sunlight fell upon that space during the growth of the vegetation, then we might actually find what proportion was expended in growth. Professor Thomson, of Glasgow, has employed these data, and finds that "probably a good deal more than $\frac{1}{1000}$th of the solar heat which falls on growing plants" becomes latent by their growth. We have said that energy of sunlight becomes latent in the growth of plants, but sunlight is itself energy, and apart from energy has no existence.* Sunlight, therefore, is stored up in plants, and since all our food is ultimately vegetable, it is this sunlight which glows in our bodies and forms our strength. "Hence," in the jocular words of Helmholtz, "we are all in point of nobility not behind the race of the great Emperor of China, who heretofore claimed to himself the sole honour of being child of the sun."

True science is the discovery of relations, of generalities; and the perfection of science is "knowing even as also we are known." The threads of discovery, unravelled with patience and painstaking, are so many clues leading to a knowledge of the workings of the first cause. When we have comprehended such a relation as that between sunlight and growth and life, the joy of knowing cannot exclude a pervading sense of awe, as if we were on the threshold of the holy of holies, and felt the near presence of God, whose being is the law of the universe. The more we know, the more cordial and constant ought to be our worship. The ox browses the pasture, and basks unthinkingly in the sunlight; but our intelligence demands that we should bead with thoughts the sunbeam, and regard the hand that holds this golden cup daily to the lips of creation.

Some plants will grow in the air, without communication with the soil. The substance of such is fixed air and latent light alone. But by far the majority of vegetables "cast anchor" in the solid earth, and lay it also under contribution. Still the vital relation of all to the sun is the same. Raleigh apostrophizes flowers as

> "You honours of the flowery meads;
> You pretty daughters of the earth and sun."

The giants of the forest, "the builder oak" and his stately compeers, are their sons. What a perpetual benefaction! High up on the verge of the Alpine snows are the "rosy fingers" of the day busy fashioning the hardy lichen; lower down clouding the rifted precipices with the darkness of the pine. They spread over our English downs and Scotch hillsides the green carpet, velvet-soft and diapered with daisies; deck shrines to beauty, offering up the incense of flowers in secret nooks, a sudden joy to the devious wanderer. Lovingly they drape hoary trees with green garniture; hang torn banners of ivy from old castle-walls, and muffle with moss the footing of the waters. But still more of poetry belongs to the tender offices of a younger sun.

One day, Stephenson, the engineer, said to Buckland, the geologist, as a train passed, leaving a trail of steam in the air, "Now, Buckland, I have a poser for you? Can you tell me what is the power that is driving

* "The value of a cubic mile of sunlight" has been calculated by Professor Thomson. It is 12,050 foot-pounds, or the work of one-horse power for twenty seconds.

that train?" Buckland guessed first that it was one of Stephenson's "big engines;" then that it was "a canny Newcastle driver." "What do you say to the light of the sun?" said the engineer. "It is nothing else. It is light bottled up in the earth for tens of thousands of years, absorbed by vegetables, being necessary for the condensation of carbon in another form; and now, after being buried in the earth for long ages in fields of coal, that latent light is again brought forth and, liberated, made to work as in the locomotive for great human purposes."*

As everybody knows, coal was not created as it now exists. It grew. Every particle was aggregated from earth and air by the help of an antediluvian sun. How does this widen our ideas of the designs of Omniscience! The coal-measures were a pledge, deep laid in the foundations of the earth, for the appearance of man. Unless viewed as a provision for man, they are meaningless and purposeless—the tomb of a useless creation. But it would seem that the coal foretold not the coming merely of man, but his advance in civilization to a height for which the energies of the world coeval with him are not sufficient. They are not equal to the necessities of his moral and intellectual progress and social comfort. A sparse rural population may supply their animal wants, their food and fire, from the produce of the fields; but as they increase in numbers, and especially when large cities begin to rise, the timber must be cleared from the soil to admit of the growth of grain. So that in the more northern temperate regions, at any rate, a country where nothing but wood or peat is burned, cannot be thickly peopled, nor be very highly civilized. The want of a cheap and abundant light also seriously affects the economy of time. We cannot convey sunlight along our streets, into warehouses, and studies, and lecture-halls; but here is its essence, so to speak, prepared in the laboratory of Nature, and laid up in store for our use. Then in its relations to iron and steam, coal appears as the great modern agent in social progress. Commerce and manufactures have reached an extent and complexity otherwise unattainable. The balance of trade is maintained with greater delicacy by rapidity of conveyance. By the cheap and ready transport of large bodies of the community to all parts of our own and other countries, local and national prejudices are wearing out, government is more under the influence of popular opinion, and the value of life is increased. We may, in short, say that in the use of coal we have the distinctive character of modern as compared with ancient civilization. It is more diffused and more comfortable. It is popular, not so narrow-minded; does not classify mankind into Greeks and "Barbarians."

* "Story of the Life of George Stephenson," p. 327.

The development of mineral wealth to the extent which these benefits imply, demands certain physical and moral qualities in the people to whose country it is native. These are, great strength of muscle and of will, hardihood and perseverance, qualities which do not exist but in the temperate regions of the globe. Here, also, we find foresight. There are no great coal-fields within the tropics. The most extensive, in proportion to area, are in Great Britain; the most extensive, absolutely, in America. The coal grew in a damp, enervating atmosphere, incompatible with bodily vigour; but the climate is changed before man is introduced, and the northmen come down strong-limbed and strong-brained.

Such are some of the correlations of facts in creation. Nothing stands alone. Even the springing of a blade of grass depends on the stability of grand cosmical laws. Nothing is mean—the mightiest ministers to the weakest. May we not draw a lesson from God's doings in the physical world, and apply it to the moral? We see that the earth has been the scene of phenomena

which pointed through ages of futurity for their reason and use. Ought we not to believe that the perplexities of the moral world hasten onward through the years to a full solution?

I seem to be carried back to an earth that was, to years, far, far "beyond the flood." The landscape is flat and marshy, scarce raised above the level of the sluggish rivers and the aggressive sea. But it is crowded with a vegetation luxuriant and gigantic. We see the exaggerated forms of species familiar to us in their present miniature state—towering tree-ferns, and club-mosses, and thickets of horse-tails, intermingled with growths to which we can find no analogy in the existing flora—trees with stems carved, like the pillars of the temple, with "knops and flowers," or bristling, "like the fretful porcupine," from root to summit with spear-shaped leaves. Insects of various form spread their gauze wings in the sun, and flit about in the forest solitudes. The scaly armour of predaceous fishes sparkles momentarily on the surface of the water, and beings of anomalous shape crawl on the plashy shore: amphibious creatures, best suited for such an age. The atmosphere is dark and noxious to human life, but through all the clouds and steamy vapours a brilliant sun beams, and nurtures the rank vegetation with floods of refreshing light. I can fancy one of those wise men with whom we sometimes meet, who are constantly throwing out suggestions to the All-wise, who think He might govern the universe a great deal better than He does—I can fancy him saying, "For what end this waste of growth, this expenditure of ways and means on an uncouth vegetation? Why pour out this sunlight on such a dark, disagreeable earth? Is it all for the sake of a few fishes, and insects, and crawling creatures?" Let the inquirer, "wise before the time," wait. Leave the carboniferous earth to tremble and shiver with frequent earthquakes, and sink with layer after layer of vegetation. Let strata of rock be deposited, and hill and valley be formed over it; and ages of animal life, crowned with man, succeed. Now, find the answer in our coal-fields, and the myriad forms of industry which they originate. The lost sunlight of an unpeopled earth lights us, warms us, and works for us with the sunshine of to-day.

Glasgow. JAS. B. RUSSELL.

THE LACE-LEAF PLANT. (*Ouvirandra fenistralis*).

IT is not alone to professional collectors, men who risk life and limb to increase our luxuries, that we are indebted for the novelties which from year to year are added to the much-prized ornaments of our gardens. Merchants and seamen, who trade with distant ports, often bring back with them the seeds or roots of some plant whose beauty has excited their admiration. Soldiers, even amid the excitement of war, find time to admire the flowers which spring up around them. As a proof of this we may point to many a Crimean iris, now blooming in English soil, which was gathered by the side of those fatal trenches. To those pioneers who are the first to push forward into the great blanks upon the map of the world, and who, like Livingstone, find a luxuriant vegetation where all had been supposed to be a barren desert, we owe many an interesting plant. And many of our choicest vegetable gems have been sent home by those devoted missionaries who have carried "the glad tidings of great joy" into lands far distant and but little

known. It is to a man of this latter class, the Rev. W. Ellis, the author of "Three Visits to Madagascar," one of the most interesting and instructive narratives of travel which has been published of late years, that we are indebted for that greatest of all vegetable wonders, the "lace-leaf plant," as well as for *Angræcum sesquipedale*, the largest flowered of all the orchids, and many other novelties of great beauty.

Mr. Ellis did what all travellers should do before setting out upon their journeyings; he inquired of scientific men what objects of interest he should search for, and the lace-leaf plant was specially pointed out to him by Dr. Lindley and others. Accordingly he took with him a drawing of it of the natural size, and, as soon as he could conveniently do so, he showed it to one of the natives, who immediately recognized the plant. But still there were difficulties in the way; the Ouvirandra is an aquatic plant, the streams were swollen to an unusual height by the heavy rains, and crocodiles were plentiful. But this persevering traveller was not to be daunted by trifles; he succeeded in procuring several plants, which he brought to the Mauritius, where it was cultivated for a season, and afterwards in glass jars of water to England. He presented plants of it to the Botanic Gardens at Kew and Regent's Park, and other gardens of note, where so great a rarity was carefully tended and sedulously increased.

Mr. Ellis himself tell us that "this plant is not only extremely curious, but also very valuable to the natives, who, at certain seasons of the year, collect it as an article of food; the fleshy root, when cooked, yielding a farinaceous substance resembling the yam. Hence its native name, *Ouviran-drano* literally, yam of the water; *ouvi*, in the Madagasy and Polynesian languages, signifying yam; and *rano*, in the former and some of the latter, signifying water."

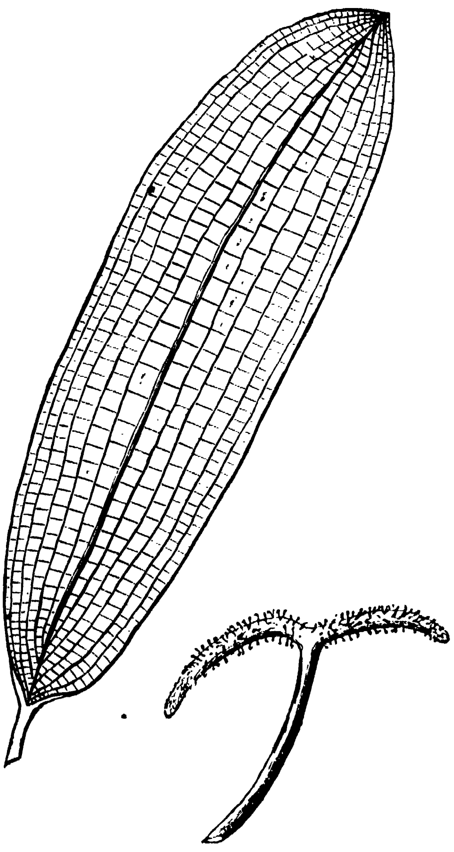
The root or rhizome of *Potamogeton natans*, an allied plant, by no means rare in the rivers of this country, in like manner furnishes an article of food to the natives of Siberia.

The Ouvirandra is, as we have already stated, an aquatic plant; its leaves are entirely

The Plant submerged.

submerged, and only the flower-scape appears above the surface. The great peculiarity of the plant consists in the highly curious structure of its leaves, which are perfect natural skeletons; in the adult and normal state of the plant there is no parenchyma connecting the veins, they are simply a network of green threads, consequently the leaf is pliant and flexible as a feather, and waves about most gracefully if the water be disturbed. The leaves are about a foot or fifteen inches long, and two inches wide in the broadest part; about twelve or fourteen nerves run from the base of the leaf, gradually expand, and then converge again towards the

apex, so as to form a lengthened oval shape. These are connected by thinner veins running at right angles to the others. The leaves are supported on footstalks of greater or less length, according to the depth of the water; for they naturally float in a horizontal position just below the surface. The individual

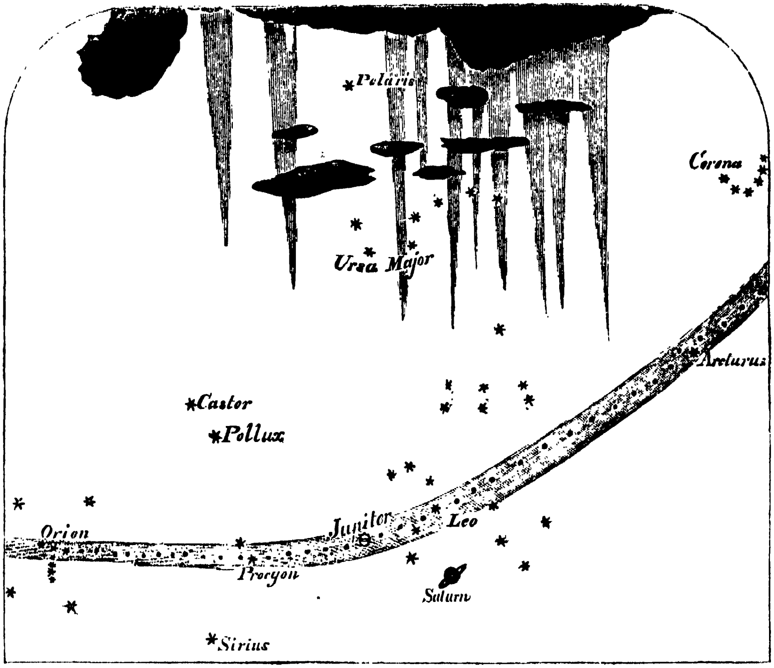


Leaf and Flower-scape.

flowers are very minute, white or pale green in colour, and thickly clustering on a forked spike. The whole habit and appearance of the plant greatly resembles that deliciously scented old Cape aquatic, *Aponogeton distachyon*, with its leaves skeletonized. The Ouvirandra should be cultivated in a broad shallow vessel of rain water. It appears to like a good strong yellow loam, better than any other kind of soil; it certainly will not succeed in peat, and if vegetable matter be mixed with the soil it is apt to discolour the water. The plant is seen to much greater advantage if the surface of the soil be covered with finely broken fragments of spar, quartz, or any other white stone. The water should be kept at a temperature of from 75° to 80° in summer, and in winter, when the plant will be at rest, 10° lower. The plant should receive all the sunshine our dull climate affords. Seeds ripened in this country vegetate freely, but are very subject to dwindle away and die, if shaded too much, or the weather be cloudy. Until the leaves have attained a length of three or four inches they do not show any symptoms of becoming skeletonized, and the intervals between the veins are filled with parenchyma, as in ordinary plants. *Ouvirandra fenistralis* succeeds so well in the aquarium at Kew, that during the last summer the leaves touched all round the side of a circular tank four and a half feet in diameter.

Among the plants of *Ouvirandra fenistralis,* brought back by Mr. Ellis on a subsequent visit to Madagascar, there was one piece with longer, narrower leaves, the network of which was, as it were, made up of stronger coarser threads. In 1858 this plant flowered in the nursery garden of Mr. Jackson, at Kingston-on-Thames, and proved to be a distinct species, *Ouvirandra bernieriana.* It is distinguished from the other plant, not only by the difference in the leaves, but by the flowers being of a rosy tint, and the flower-stem bearing three or five, instead of two branches; the scape is also swollen towards the upper end. This is a much rarer plant in this country than *Ouvirandra fenistralis.* They will both succeed under the same treatment. C. W. Crocker.

Royal Botanic Gardens, Kew.



AURORA BOREALIS SEEN AT THE BEESTON OBSERVATORY, MARCH 9th, 1861.

THE Aurora borealis of this evening has not been surpassed in magnificence and brilliancy for some years. The milk-white arch was delicately beautiful beyond description. In 1841, on the 22nd of March, Professor Phillips, at York, and Professor Stevelley, at Belfast, saw a similar arch, and one less beautiful was seen at the Highfield House Observatory on the 3rd of December, 1845.

Throughout the evening there was an auroral glare, which increased in intensity until from 9 till 11 p.m. The sky was a blaze of various coloured beams, coruscations, and arches. There was a low arch in the north, a red arch reaching to the altitude of Polaris, and a colourless arch south of the zenith. It was a broad band of soft, calm, strong, steady, dazzling white light, broadest at the apex, and apparently rolling round upon itself with great rapidity, with a short, tremulous, vibratory, and undulatory motion. Almost stationary. The stars were not dimmed by it, and those of the 3rd and 4th magnitudes were visible through it. Jupiter, on the contrary, was very sensibly dimmed by it, and at times a burr was formed round this planet. At 10h. 18m. the arch passed through the following stars :—Commencing at Orion's belt (those three stars being 20′ within the arch), it passed through Procyon, Jupiter, and Arcturus, and extended 15° below the latter star. The arch varied in brightness. At 10h. 32m. there was a bending of the arch about Jupiter, and between 10h.

20m. and the time of its disappearance, the arch split almost longitudinally several times, both in the N.E. and in the extreme W., and reunited.

This Aurora was well seen by Sir John Herschel at Hawkhurst, by M. Amyot at Diss, and by several other good observers, and, therefore, some valuable information will be obtained. With regard to the height of the colourless arch above the earth, owing to its position, a small error of observation will make a grave error in the calculations; nevertheless, hopes are entertained that a close approximation to the true height above the earth will be obtained. A rough calculation gives the height at from 82 to 86 miles. E. J. LOWE.

METEOROLOGY OF MAY.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Mean Temperature of the Air. Degrees.	Mean Temperature of the Dew Point. Degrees.	Mean Pressure of the Air. Inches.	Mean Amount of Cloud. (0—10).	Number of Rainy Days.
1846	57·3	—	29·652	5·4	7
1847	59·3	51·0	29·771	5·0	20
1848	60·0	50·0	29·962	1·4	7
1849	52·9	45·9	29·787	7·6	19
1850	49·7	40·6	29·727	7·3	18
1851	51·3	43·9	29·902	6·3	10
1852	51·5	44·0	29·800	7·7	13
1853	50·4	42·5	29·816	8·1	7
1854	50·0	45·0	29·610	6·6	19
1855	49·6	40·3	29·688	7·6	19
1856	48·5	42·0	29·655	7·7	21
1857	52·5	43·8	29·805	7·9	12
1858	52·5	42·7	29·738	7·9	12
1859	52·3	44·6	29·840	6·2	8
1860	54·2	49·4	29·709	7·2	17
Mean	52·8	44·7	29·766	6·9	14

The mean temperature of the air for the last fifteen years, for May, is 52·8°, the range in the mean temperature being from 48·5° in 1856 to 60·0° in 1848—a difference of 11·5°. The lowest means occurred in 1850, 1853, 1854, 1855, and 1856, and the highest in 1846, 1847, 1848, and 1860.

The mean temperature for May, for the last fifty years, is 53·1°, or 0·3° higher than that of the past fifteen years. It was as high as 60·0° in 1848, and as low as 48·5° in 1846, thus the highest and lowest means during the past fifty years have occurred within the last thirteen years. The mean temperature of May is 5·8° higher than that of April.

The mean temperature of the dew-point for the last fourteen years, for May, is 44·7°, the range being from 40·3° in 1855 and 51·0° in 1847—a difference of 10·7°. In 1848 the mean temperature of the dew-point was 10·0° below the temperature of the air, and in 1860 only 4·8° below that of the air, the mean difference of the last fourteen years being 8·1°.

The mean pressure of the last fifteen years, for May, is 29·766 inches at the height of 174 feet above the mean sea-level, ranging between 29·640 inches in 1854, and 29·962 inches in 1848—a difference of 0·322 of an inch (or three-tenths of an inch). To reduce these readings to the mean sea-level, it is necessary to add 0·187 of an inch, when the mean temperature of the air is as low as 48·5°, as in 1856; and 0·183 of an inch when it is as high as 60°, as in 1848. On applying this correction, the mean pressure of May, of the last fifteen years, when reduced to the sea-level, is 29·951 inches.

The mean amount of cloud, for May, of the last fifteen years is 6·9 (or under seven-tenths of the whole sky); the amount being as much as 8·1 in 1853, and as little as 4·4 in 1848—a difference of 3·7 (or above a third of the whole sky).

The mean number of rainy days, for May, of the last fifteen years is 14, ranging between 7 in 1846, 1848, and 1853, and 21 in 1856—a difference of 14 days. The years of but little rain are 1846, 1848, 1851, 1853, and 1859; and of much rain 1847, 1849, 1850, 1854, 1855, 1856, and 1860. E. J. LOWE.

ASTRONOMICAL OBSERVATIONS FOR MAY, 1861.

THE Sun is in the constellation of Taurus until the 21st, when he passes into that of Gemini. He rises in London on the 1st at 4h. 34m., on the 10th at 4h. 18m., on the 20th at 4h. 4m., and on the 31st at 3h. 52m.; setting on the 1st at 7h. 21m., on the 10th at 7h. 35m., on the 20th at 7h. 50m., and on the 31st at 8h. 5m. He is above the horizon in London on the 1st, 14h. 47m., and on the last day 16h. 13m.

The Sun rises at Edinburgh on the 10th at 3h. 59m., on the 20th at 3h. 41m., and on the 27th at 3h. 30m.; setting on the 11th at 7h. 56m., on the 21st at 8h. 15m., and on the 28th at 8h. 26m.

The Sun rises at Dublin on the 7th at 4h 15m., on the 18th at 3h. 58m., and on the 25th at 3h. 47m.; setting on the 8th at 7h. 39m., and on the 19th at 7h. 58m.

Day breaks in London on the 4th at 1h. 54m., on the 14th at 1h. 12m., and on the 20th at 12h. 40m.

Twilight ends on the 5th at 10h. 6m., on the 15th at 10h. 48m., and on the 25th there is no real night.

The Sun is on the meridian in London on the 1st at 11h. 56m. 56s.; on the 15th at 11h. 56m. 7s., and on the 31st at 11h. 57m. 22s.

The equation of time is on the 1st, 3m. 4s. sub-

tractive (or after the Sun); on the 15th 3m. 53s., and on the 31st 2m. 38s.

The Moon is new on the 9th at 11h. 8m. p.m.

Full Moon on the 24th at 6h. 6m. a.m.

She is at her greatest distance from the earth on the 7th, and nearest to the earth on the 22nd.

Mercury is a morning star, and will be seen at the beginning of the month; situated in Pisces at the beginning, and in Taurus at the close of the month. He rises on the 1st at 4h. 6m. a.m., on the 16th at 3h. 51m. a.m., and on the 31st at 4h. 17m. a.m.; setting on the 1st at 5h. 18m. p.m., on the 16th at 7h. 7m. p.m., and on the 31st at 9h. 13m. p.m.

Venus is unfavourably situated for observation, being at her greatest distance from the earth. She is in Aries at the commencement of the month, and in Taurus at the close. She rises on the 1st at 4h. 30m. a.m., and on the 31st at 4h. 7m. a.m.; setting on the 1st at 7h. 4m. p.m., and on the 31st at 8h. 33m. p.m.

Mars is becoming faint. He is in Taurus at the commencement, and in Gemini at the close of the month. Rising on the 1st at 6h. 11m. a.m., and on the 31st at 5h. 36m. a.m.; setting on the 1st at 10h. 53m. p.m., and on the 31st at 10h. 22m. p.m.

Jupiter is in the constellation of Leo, and is a brilliant object in the evening. He rises on the 1st at 11h. 12m. a.m., on the 16th at 10h. 19m. a.m., and on the 31st at 9h. 29m. a.m.; setting on the 1st at 2h. 18m. a.m., on the 16th at 1h. 21m. a.m., and on the 31st at 12h. 27m. a.m.

Saturn is also in the constellation of Leo, and favourably situated for observation during the evening. He rises on the 1st at 12h. 35m. p.m., on the 16th at 11h. 37m. a.m., and on the 31st at 10h. 41m. a.m.; setting on the 1st at 2h. 55m. a.m., on the 16th at 1h. 55m. a.m., and on the 31st at 12h. 57m. a.m.

Uranus is in Taurus, and very near Venus on the evening of the 28th. Rising on the 1st at 5h. 51m. a.m., and on the 31st at 3h. 58m. a.m; setting on the 1st at 10h. 3m. p.m., and on the 31st at 8h. 12m. p.m.

Diameter of the Planets:—Jupiter 35·8″ on the 1st, and 33·4″ on the 25th. Venus 9·6″ throughout the month. Mercury 5·7″ on the 1st, and 5·0″ on the 25th. Mars 4·0″ on the 1st, and 3·8″ on the 25th.

Occultation of Stars by the Moon:—On the 17th, No. 16 Sextantis (6th magnitude) disappears at 10h. 33m. p.m. On the 18th, p. ² Leonis (6th magnitude) disappears at 11h. 50m. p.m., and reappears at 12h. 41m. a.m. On the 19th B.A.C. 4006 (6th magnitude) disappears at 8h. 53m. p.m., and reappears at 10h. 3m. p.m. On the 23rd B.A.C. 5107 (6th magnitude) disappears at 8h. 20m. p.m., and reappears at 9h. 14m. p.m. On the 24th No. 3 Scorpii (6th magnitude) disappears at 12h. 41m. a.m., and reappears at 1h. 30m. a.m.

Eclipses of Jupiter's Satellites:—On the 2nd, at 12h. 56m. 34s. a.m., 2nd moon reappears. On the 6th, at 9h. 18m. 21s. p.m., 1st moon reappears. On the 13th, at 11h. 13m. 25s. p.m., 1st moon reappears. On the 26th, at 10h. 2m. 17s. p.m., 2nd moon reappears. On the 29th, at 9h. 32m. 25s. p.m., 1st moon reappears.

E. J. Lowe.

THE MICROSCOPIC OBSERVER. MAY.

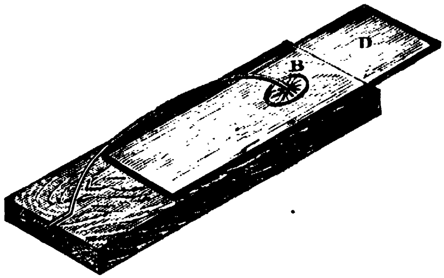
Aphides.—What a pressure of painful reminiscences, what a cloud of forebodings come over the mind of the gardener at the mention of this tribe of rapacious plant-destroyers. The locust is a harmless creature compared with the aphis; all the blights, mildews, and visitations of east winds are as nothing to the ravages during a few days of a sudden visitation of plant-lice. To the microscopist there is no more entertaining subject than the history of these creatures, and their curious methods of reproduction. With a Coddington lens to assist in collecting species, a garden will furnish an endless succession of studies for the microscope, from the fat *Aphis rosæ* crowding the young shoots of the "budding rose," to the myriads of negro aphides that encrust the stems of the garden bean, the peach, and the cherry. The aphis belongs to the order *Hemiptera*, and the characters are as follow:—Rostrum of four joints, perpendicular or inflexed; labrum long and pointed; antennæ setaceous or filiform, 5-7 jointed, third joint longest; ocelli three; eyes entire, prominent; thorax oval; abdomen short and convex, soft, with elongated tubercle on each side, near the extremity. Wings four, anterior largest; legs long and slender; tarsi two-jointed. The anterior wings are a good and distinct study for the determination of the subcostal nerve and branches to the posterior margin, and the stigma in which it terminates. There is scarcely any plant but is some time or other visited and preyed upon by some species of aphis, and many plants have their own particular species from which they are scarcely ever free. Their manner of feeding may be observed by means of the Coddington. It will be seen that with the rostrum the tissues are pierced, and that by lateral movements the wound is enlarged to cause a ready flow of the sap, which is abstracted by suction; hence their appearance on young shoots chiefly, or on the mature growth only of such plants as do not form a hard cuticle. The tubercles at the extremity of the abdomen are generally regarded as excretory ducts, which exude a saccharine fluid, but opinions are not unanimous on this point. It is certain, however, that aphides produce large quantities of saccharine exudation, and that this is the origin of honey-dew. Wherever ants are seen running to and upon wall-trees and roses, the observer may be sure that there are colonies of aphides not far off. Gardeners usually consider hymenopterous insects as natural enemies of the aphis, and as largely aiding in keeping down their numbers; but this we are sure is a mistake. No hymenopterous insect ever destroys or checks the spread of aphidæ; they simply resort to their feeding-grounds to obtain the saccharine excretion, not to molest or destroy them. Their real enemies are *coccinella*, the larvæ of *syrphus*, the smaller *ichneumonidæ* and *chalcididæ*. In Westwood's Introduction and Kaltenbach's Monogram, "Der Pflanzenlause," are the best lists of genera and species, to which reference must be made for the cha-

racters of the kinds collected. The aphides of the turnip, hop, bean, rose, oak, and apple are all distinct, and represent very fairly the several divisions of this destructive family. *Eriosomæ lanigeri* is the "American Blight" of gardens; the abdomen is without tubercles; antennæ short and threadlike; the whole body covered with a white cottony down, secreted by roundish warts set in rows upon the back. This destructive and stubborn pest is a really beautiful subject for microscopic examination, and should be sought in the winged and apterous state. The males are always winged; the females only occasionally so. *Aphis rosæ*, the terror of the rose-grower, is a very elegant and finely-formed aphis. It varies in colour with the colour of the shoot on which it is feeding, green on a green shoot, red on a red one. By a little careful manipulation in the preservation of a colony indoors under a bell-glass, the whole life-history of this curious creature may be studied in detail, from the changing of the skin to the apparent spontaneous reproduction, on which so much has been said and written. This is the species on which Réaumur founded his curious calculation, that one female may be the progenitor, during five successive generations, of not fewer than five million individuals. The microscopist will also do well to look for *Lachnus quercus*, which is common in oak woods, in the fissures of the old trees. It is a large species, with an immense rostrum. *Lachnus pinicola* may be found on the young shoots of coniferous trees at this time of year most abundantly. The aphis of the elm, *Tetraneura ulmi*, causes the formation of the small, gall-like excrescences seen on the leaves of elms, in which it takes up its residence, and abstracts the juices to an extent that sometimes visibly checks the seasonal growth of the tree. It is a pretty, brown-bodied aphis, with broad, well developed wings. *Forda formicaria* is a green aphis, with oval abdomen, short antennæ, found on the roots of grasses. This is the aphis specially cared for by the ants, which collect them about the vicinity of their nests, and tend them with great care, for the sake of their saccharine excretions; they are, *par excellence*, the "ants' cows" of Huber, and other observers. On the reproduction of aphides, Professor Huxley has furnished the most reliable and recent memoirs, the result of long and patient observation, as well as of direct experiment. As at this season observations may be commenced with a view to test, during the course of the summer, the conclusions hitherto accepted, we cannot do better than condense the results of Professor Huxley's *resumé*:—"It was between the years 1740 and 1750, in fact, that Bonnet, acting upon the suggestion of the illustrious Réaumur, isolated an aphis immediately after its birth, and proved to demonstration that not only was it capable of spontaneously bringing forth numerous living young, but that these and their descendants, to the ninth generation, preserved a similar faculty. Observations so very remarkable were not likely to pass unheeded, but, notwithstanding the careful sifting which they have received, Bonnet's results have never been questioned. On the contrary, not only have Lyonnet, De Geer, Kyber, Duvau, and others, borne ample testimony to their accuracy, but it has been shown that, under favourable conditions of temperature and food, there is, practically, no limit to this power of a sexual multiplication, or, as it has been conveniently termed, "agamogenesis." Thus Kyber bred the viviparous *Aphis dianthi* and *Aphis rosæ* for three years in uninterrupted succession; and the males, and true oviparous females, of the *A. dianthi* have never yet been met with. The current notion that there is a fixed number of broods, "nine or eleven," is based on a mistake. As, under moderately favourable conditions, an aphis comes to maturity in about a fortnight, and as each aphis is known to be capable of producing a hundred young, the number of the progeny which may eventually result even from a single aphis, during the six or seven warm months of the year, is easily calculated. M. Tougard's estimate, adopted and acknowledged by Morren, and copied from him by others, gives the number of the tenth brood as one quintillion. Supposing the weight of each aphis to be no more than 1000th part of a grain, the mass of living matter in this brood would exceed that in the most thickly-populated countries in the world. The agamogenetic broods are either winged or wingless. The winged forms at times rise into the air, and are carried away by the wind in clouds; and these migrating hordes have been supposed to be males and females, swarming like the ants and bees. During the summer months, it is unusual to meet other than viviparous aphides, whether winged or wingless; but ordinarily, on the approach of cold weather, or even during warm weather, if the supplies of food fall short, the viviparous aphides produce forms which are no longer viviparous, but are males and oviparous females. The former are sometimes winged, sometimes wingless. The latter, with a single doubtful exception, are always wingless. The oviparous females lay their eggs, and then, like the males, die. It commonly happens also that the viviparous aphides die, and then the eggs are left as the sole representatives of the species; but, in mild winters, many of the viviparous aphides merely fall into a state of stupor, and hybernate, to reawake with the returning warmth of spring. At the same time the eggs are hatched, and give rise to viviparous aphides, which run through the same course as before. The species aphis, therefore, is fully manifested, not in any one being or animated form, but by a cycle of such, consisting of, 1st, the egg; 2nd, an indefinite succession of viviparous aphides; 3rd, males and females eventually produced by these, and giving rise to the egg again.

OUT-DOOR STUDIES.—*Hemerobius perla*, the beautiful lace-winged fly, may be expected as soon as the weather is warm and settled. It is an insect of some importance, inasmuch as its larvæ are among the most active destroyers of aphides. The fly is an elegant and lively creature of but a few days' duration. It may be easily recognized by its unique character; the four lace-like wings, fringed with greenish hairs—the slender thorax, the long antennæ, the delicate green of the abdomen, and the sparkle of the eyes bright as

burnished gold. Here is a fine subject for microscopic study. In the wings the circulation is beautifully exhibited, and the markings of these gauze-like appendages form a geometric pattern wonderfully symmetrical and complete. In the veins of the wings may be traced the trachea. Another enemy of the aphis is the *Syrphus*, a two-winged fly, strongly resembling at a casual glance the honey-bee. Though this fly does not offer points for observation in any way unique, the larvæ are interesting. These are of a tapering form, capable of contracting or extending their bodies in length, and the head is armed with three prongs like a trident, with which they transfix their prey; this apparatus does not require a very high power for its delineation. The species of *Gyrinus* recently described by Mr. Samuelson, may now be found in plenty on the margins of ponds and still streams. Many of the *Lepidoptera* are now plentiful, and as the season progresses a constant succession of species will be presented. The feathers of the wings are among the best of all subjects for the practice of beginners. When the feathers are brushed away, the wing of a butterfly will resemble those of the *Hemerobius*, a network of ribs connected by a delicate transparent and elastic membrane. The ribs are hollowed, by which contrivance a wing, though broad and extended, still retains its lightness, and on the membrane rows of dots are seen, where the scales were attached to its surface. *Papilio archippus* has the scales regularly disposed like a series of escutcheons, and where the scales are recurved the stigmata are triangular. The breadth of the stigmata is the sixteen hundred and fiftieth part of an inch, and the width of the scales the two hundred and fiftieth of an inch. In *Lepisma saccharina*, the scales of which are used as test-objects, there are two distinct sets of scales, one set arranged in rows, and the other of a different shape, are inserted between and over the former, so as to fasten them firmly in their places. *Lycæna argus*, a beautiful blue butterfly, has on the under side of the wings scales resembling battledores, with strings of beads running lengthwise over the surface parallel to each other. On the wing of a silkworm moth, Leuwenhoeck counted over 200,000 scales; in the Atlas moth, which measures nearly a foot across the wings, the number is almost beyond estimation. The scales of the Death's-head Moth are as curious as any other subject in this department of Microscopic Observation. We may remind our readers that now the vegetable kingdom offers an endless variety of subjects in pollen cells, incipient ovaries, hairs, glands, crystals, spiral fibres, etc., and the commonest wayside weed has lessons as profound in the economics of its structure as the rarest and most noble of floral productions.

SPRING-CLIP FOR MICROSCOPIC PURPOSES.—The above is a diagram of a spring-clip for holding microscopic objects during preparation. It is formed of a piece of brass wire, A B, and a piece of mahogany, about three and a-half by one and a-half inches. The wire is bent into a spiral at A, and the end is inserted into the wood; the other part of the wire is bent into an arch, so as to allow the end, B, to fall perpendicularly upon the wood, as is shown in the drawing. D is the slide. It is so simple that any one may make a dozen in an hour or two, and at a cost not much



exceeding sixpence. The end, B, may be fitted with a piece of India-rubber or cork, to prevent its injuring the cover-glass.

Mr. Noteworthy's Corner.

RARE SHELLS.—Although shells are not a fancy of mine, I have been very much interested with Mr. Woodward's article in RECREATIVE SCIENCE. My object in writing to you now is to mention another "curiosity in shells." In June, 1859, a certain ship was wrecked in the Red Sea, and a great quantity of the passengers' baggage was recovered. One of the passengers, a Mr. C., from Madras, asked me most particularly whether two shells had been found. On opening one of the packages we found the shells. They were in shape somewhat like *Conus cedo nulli*—a kind that I have often seen at the docks. He took one in each hand, and said, "One of these shells is not worth a penny, and the other I gave twenty guineas for." At a casual glance they appeared alike. He explained that one was a *king* shell, as it is called by the natives; the difference was that it was a *reverse* shell to the other; that is, they formed *a pair*. If you notice, all the drawings in RECREATIVE SCIENCE show the mouth in the *right* hand side, in this shell the mouth was in the left. The owner of the shells said that only one or two of these shells had been found before, the last about fifty years ago; that the natives held them in great veneration, and the ones previously found had been embellished with jewels, and used to decorate the high temples. He intended to have his one jewelled, and expected to obtain a very large sum for it on his return to Madras.—C. D. T.

THE CUCKOO AND ITS EGGS.—The question of the "Cuckoo and its Eggs" involves several very curious points, which have been investigated by German ornithologists. There seems to be no doubt that each cuckoo lays several eggs, though seldom, it would appear, more than one in the same nest. The variations of colour presented by the eggs of the cuckoo are very extraordinary, seeming generally to

mimic those of other birds, among whose eggs they are deposited. Thus they are sometimes marked like those of the wagtail, sometimes speckled like a meadow pipit's, and occasionally of a pure pale greenish blue, like a hedge-sparrow's. There can be little doubt that this is intended to deceive the foster parent of the young cuckoo, and it also seems as if the same female always laid eggs of the same colour, and hence instinctively deposited them in the nests of the same species. Only when it cannot find a nest of this species does it impose the care of its young upon another, which explains the occasional exceptions to the general rule given above. It also seems as if the egg were always previously laid on the ground and deposited in the nest by the mouth. Female cuckoos have been shot with an egg half-swallowed, and hence the old superstition that the cuckoo laid its egg through its mouth. Where the egg has to be laid in a very small nest, which the cuckoo's weight would break down, or in one in a hole where it could not enter, this would be a necessary precaution; but it appears to be adopted in other cases, as, when the nest is on the ground, of course very few birds would be able to take their egg in their mouth, but the cuckoo's gape is rather wide, and the egg extraordinarily small for the size of the bird. Those who wish for detailed information on these points will find some interesting investigations in a German ornithological periodical, "Naumannia," edited by E. Baldamus, for 1853, p. 307. To be had in London of Williams and Norgate.

Habits of the Lapwing and the Hedgehog.—Mr. Martin, in his interesting description of the Kiwi, in the first volume, p. 41, of Recreative Science, doubts the alleged habit of the bird of stamping on the ground to disturb the worms, in order to seize them when they make their appearance; and he adds, "a similar habit has been attributed to our lapwing, but no one who has studied the economy of this lightly-tripping bird can, upon consideration, believe that the stamping powers of its feet are so energetic as to disturb the worm in its retreat." I have for some years kept lapwings in my walled garden, and have very frequently seen them stamp the greensward, opposite my dining-room window, especially after rain, and pick up worms, disturbed in their retreat by the stamping powers of this lightly-tripping bird. I have kept in the same garden with the lapwings two hedgehogs for the destruction of slugs, beetles, etc. Two broods of young ducks being at the same time put under coops in the garden, I observed every morning their number was reduced, which I attributed to rats. One morning my servant happening to go very early in the morning to feed the ducks, observed one of the hedgehogs with a young duck in his mouth. He did not relinquish his prey, but rolled himself up, retaining the duck in his mouth. I mention this fact because I have read of hedgehogs being very innocent animals, living chiefly upon insects, slugs, worms, etc. On the contrary, they are very destructive of the young broods of pheasants, partridges, etc., and all gamekeepers endeavour to exterminate them. They are accused, I think erroneously, of sucking cows of their milk. They are certainly very fond of milk, with which I was in the habit of feeding them. My hedgehogs would, soon after dark at night, scratch at my dining-room window, which was level with the ground, and which I thereupon opened, placing in the room a plate of milk for my friends. They would boldly enter the room, lap up the milk, and then, after making a few circuits of the room in search of insects, would retire into the garden. They feed only during the night. I always could find them in the daytime, but any one unacquainted with their habits would have had great difficulty in discovering their whereabouts, for they always ensconced themselves amongst the trees in the shrubbery, and covered themselves entirely with dry leaves several inches in thickness. You may depend upon the truth of what I state, which I could substantiate by a host of witnesses.—Thos. Selby, *Boulogne-sur-Mer*.

Gold and Silver Plate Marks.—Mr. Noteworthy is asked by a connoisseur of plate and jewels for a key to ascertain the dates of plate by the marks. As the information may be of general interest, he has much pleasure in giving the following particulars, which he may be able to add to at a future time:—London bears a Leopard's Head, a Lion passant, and a Queen's Head; Sheffield bears a Crown, and K, 1832; Birmingham bears an Anchor; Newcastle bears Three Castles (one upon two); Exeter bears a Castle and Queen's Head; Edinburgh bears a Queen's Head, Lion, and Thistle; Glasgow bears a Tree, with Bell and Salmon; Ireland bears a Harp. In London, the assay year commences on the 30th May, and the date marks are continued regularly with twenty letters of the alphabet, using in succession, Roman capitals, Roman smalls, and old English capitals. The series of London date marks, commencing May 30, 1796, are as follow:—A to U from 30th May, 1796, to 29th May, 1816; a to u from 30th May, 1816, to 29th May, 1836; 𝔄 to 𝔘 from 30th May, 1836, to 29th May, 1856; 𝔞 from 30th May, 1856, to 29th May, 1876.

New Planets.—Information has been received of the discovery of a new minor planet (63) by M. Annibal de Gasparis, at Naples, on February 10, 1861. The following was its then position:—

	M.M.T.	R.A.	Decl.
Feb. 10..	14h. 33m. 18s...	11h. 11m. 42s...	+5° 18′ 49″

Its daily motion in R.A. is about 42s.; in declination very small. Another new minor planet (64) was discovered by M. Tempel, at Marseilles, on March 4. It has been named Angelina. Its position was as follows:—

	M M.T.	R.A.	Decl.
March 4..	14h. 40m...	12h. 3m. 56s...	2° 5′ 26″

Its daily motion in R.A. is about 45s.; in declination, about 4′ 8″. A second new planet (65) was discovered by M. Tempel on March 9. Its position was as follows:—

	M.M.T.	R.A.	Decl.
March 9..	11h. 24m...	12h. 6m. 19s...	+1° 1′ 46″

G. F. Chambers.

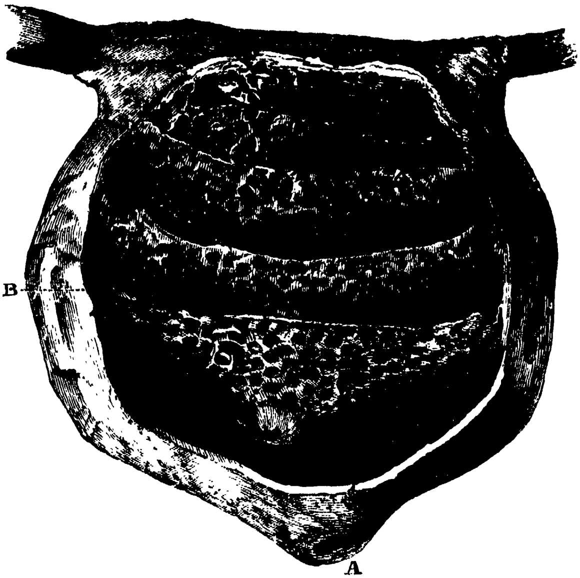


FIG. 1.—Nest of Tree Wasp, British Museum. A, entrance; B, hexagonal cells.

WASPS.

THE history of bees has been so often written, and has afforded so much entertainment to the public, that I think the history of wasps cannot fail to be interesting. Most persons have no desire to learn anything about wasps, and are quite contented to think them vexatious little insects, who destroy fruit and sting without provocation. Without wasting time at present in refuting these calumnies, I must merely beg the reader to peruse the following pages with candour and attention. But before I commence, it is necessary to state that we shall frequently differ from the received accounts, which abound in false facts and crude conclusions, and that my remarks in the present pages are confined to the *Vespa vulgaris*, or common wasp. I should also add that all the facts I relate I have myself observed.

There are three kinds of wasps in every hive—females, males, and neuters; or, according to the more common classification, queens, drones, and workers. The female alone, like the female of most wild bees, lives through the winter. Late in the autumn, after she has become fertile, she hides in some warm place, either in the thatch of a cottage or in decayed wood. There she sleeps all the winter. She does not awake till the latter end of spring, when the warm suns of April call her and other slumbering insects from a torpid repose. Her first object is to find a suitable place for constructing her nest. It is a curious fact, and one that has not been before noticed, that the wasp *always* builds her nest beside that of the wild bee. I have never, out of the hundreds of wasps' nests I have seen, found an exception to this rule.

The great object of the queen is to discover a bee's nest, which at this season of the year, when it only consists of one bee, is no easy thing to do. Most writers have supposed that the deserted hole of a mole or field mouse was the object of her search, but we see the error of such an assumption. Of course, if the hole of the field mouse or mole happen to be near the bee's nest, the wasp will have no objection to appropriating it for her use. This discovery of wasps generally building beside bees explains satisfactorily why wasps in spring appear to take so much trouble in selecting a suitable place, and why the places when chosen are so dissimilar. Sometimes wasps are found in woods, sometimes in mossy ditches, and before I made this discovery I was at a loss to find by what rule the localities for their colonies were chosen.

As soon as a suitable place is selected, the queen, alone and unaccompanied by any followers whatever, commences to build. She constructs two or three cells. In these she lays a few eggs. In the space of a fortnight the young wasps, which at this season are always workers, are hatched, and these immediately lend their assistance to enlarge the nest and feed the young. But before we proceed it will be necessary to say how the queen constructs her original cells, to explain the material of which the cells are made, to show how the nest is enlarged, and to give a detailed account of the food both of the young and of the old.

The principal food of the wasp is composed of animal substance, and this is probably the reason why he is so ferocious. He banquets on the secretions of some animals, and on the bodies of others. He is the terror of lesser insects, who fly tremblingly from his presence. In the earlier part of the year, whilst the colony is in its most flourishing condition, wasps live entirely on animal food, but in the latter and warmer months they consume considerable quantities of fruit. And this has brought the wasps into unmerited odium among persons who will not reflect, or who perhaps are ignorant, that were it not for the wasps four times as much fruit would be consumed by flies. Any observant gardener will always admit that flies are more destructive than wasps. It appears, then, that wasps, instead of being our enemies, are in reality our benefactors, that they rid us from swarms of little insects, which with all our skill we never could destroy, and that instead of consuming they preserve for us the mellow and delicious fruits of summer. But to return to what I was saying about their food. I have frequently observed, about four or five in the morning, that the leaves of beech and other timber-trees literally swarm with wasps, who are probably collecting the secretions which numerous insects have dropped there on the previous day. When wasps begin to eat fruit and to collect sweets, they lose all their former ferocity and energy. I cannot say whether the loss of their energy and ferocity urges them to eat fruit, or whether the eating of fruit deprives them of their energies. The young are fed by a juice which the wasp discharges from its mouth like the pigeon.

The nest of the wasp is constructed in a most curious and ingenious manner. It is surrounded by a shell. This shell or covering presents the appearance of cockle shells joined together. When the wasps find it necessary to enlarge their nest they build new cockle shells outside and cut away the inside. This is admirably contrived to exclude damp, which is most destructive, and to use as little material as possible. The tree wasp, I may observe, does not make cockle shells. The covering of his nest is formed by laying successive layers of paper over each other; but, as my remarks in these few pages are confined to the ground wasp, I shall say no more about the tree wasp.

It now remains for me to describe the material of which cells are made. The fibrous

part of dried wood is what is used for this purpose. These fibres being moistened with a kind of gluey juice which the wasp emits, are spread out into layers, and then fashioned into the required shape. The juice used for this purpose is collected, I fancy, from the buds of fir-trees. Groves of young fir-trees invariably swarm with wasps during the building season, and I dare say that they are procuring some kind of resinous substance from the young buds. I know nothing of chemistry, but if some one would take the trouble of analyzing the cells of the wasp, he could immediately decide the point.

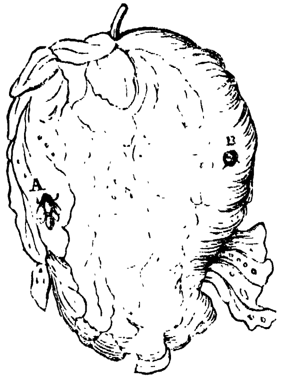


FIG. 2.—Exterior of Nest of Common Wasp. A, entrance; B, place of exit.

Wasps frequently build in decayed stumps, in order, as it is vulgarly supposed, to procure rotten wood without much labour. If the reader recollect what was mentioned before, he will at once perceive the erroneousness of this doctrine; and, besides, the wood in rotten stumps being damp is unsuited to their purposes. The real reason of this building in rotten stumps is because the bumble-bee is peculiarly fond of such places, since she can easily burrow in them. The wasp cuts the dried fibrous part of the wood of palings or posts; a load is procured in about ten minutes. When a wasp has obtained as much as he can conveniently carry, he flies in a direct line to his nest. One of the best ways of discovering a wasp's nest is to follow with your eyes a wasp returning home laden with wood, since he flies both straightly and slowly. Then, if you go to the place where the wasp became invisible, and wait until you see another flying in the same direction, you will very soon find the nest. I used to be so skilful in finding nests that I frequently found four in an hour. For the purpose of watching the wasp, it will be wise to observe him, if you can, flying along a grove or across some dark object, as he is of a light colour, and will then be easily seen. It requires considerable practice to know when a wasp is going or returning from his nest. In returning their flight is always slow and steady, whereas when leaving their hive they fly fast and uncertainly. An experienced eye can always tell the difference.

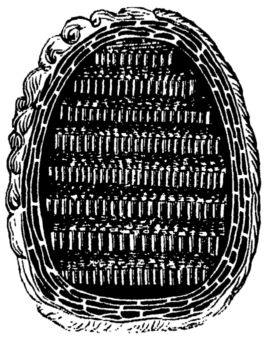


FIG. 3.—Interior of Nest of Common Wasp, showing horizontal combs of hexagonal cells.

I once had the pleasure of seeing a wasp's nest in its earliest stage; it was about the size of a blackbird's egg. In it there were two or three rude cells. The wasp always commences to build from the top, and builds downwards. Most persons know how the tree wasps attach their nest to a branch, and accordingly they will easily understand how it is that the ground wasp in a similar way attaches his to a fibre. The nest of a ground wasp is suspended in a way precisely similar to that of the tree wasp. Moreover, in no point does it touch the surrounding earth; thus it is, in a great measure, free from damp.

Unless a wasp has a fibre, or something to which he can fasten his nest, he will not build. This I proved by some interesting experiments which I shall relate hereafter. The combs inside are fastened together by

strong pillars, of which most of my readers have probably seen engravings in entomological books.

We have now seen how the wasp chooses the site for his city, what materials he employs, what is his food, how he works; and we shall now describe the rapid progress of the colony in size and prosperity. Towards the end of June a wasp's nest is still small, but during July it increases rapidly, and in the middle of autumn may be said to have reached its culminating point. The order which reigns in the hive is marvellous. The inhabitants never seem to quarrel with one another, and all perform their duties cheerfully. *Fervet opus.* Some scoop out the earth so as to leave room for the growing combs. If large stones come in the way of the little miners, they excavate the earth from under them, like burying beetles, and thus gain the required space. They lift stones larger than their own bodies, which is a feat few men, I should fancy, could do· Some forage the country for food; some cut wood for building; some clear the combs and keep the inside tidy and clean; some cut away the grass which is continually springing in front of the hole, and thereby annoying the flight of those who are returning home. Wasps like to fly into their hole. Besides, if grass or any other impediment be in the way, they are liable to drop from their mandibles the food which they have collected with great labour. The largest wasps' nests always have large holes, and if twigs or grass intervene between the hole and the open air, the nest seldom grows to any considerable size.

It is about this time that the eggs of the females are laid, and shortly after the wasps begin, as it is termed, to "queen." It is said that in a large nest there are more than a hundred females. This is probably a little extravagant, as fifty is an unusually large number. These females lay no eggs this year. Along with the females are born the males, who lead a delicious life of idleness and love. Born in the most charming season of the year, nourished in luxury, free from every care or labour that can harass or fatigue, revelling in voluptuousness, and dying in their youth unacquainted with sorrow, they fill the mind of man, a nobler and more glorious being, with envy and wonder. These happy beings are not treated in the same ruthless manner that the drones are by the bees, but, on the contrary, are regarded with admiration and respect by the whole community.

The wasp has now discharged the important duties which Nature has imposed on him; and, accordingly, he turns from the sterner labours of life to the softer allurements of pleasure. He plunges into a reckless vortex of dissipation. His only care at this period of his life is to gratify himself. From morning till night he revels in intoxicating sweets; and it is thus that he has fallen into disrepute among the ignorant.

And now quickly the season changes, and the cold nights and mornings denote the rapid decline of the year. Nowhere is this change more apparent than among the wasps. Their energies forsake them. The queen ceases to lay any more eggs. Food is not so plentiful. A general melancholy reigns in the nest. A few still collect food, but they do it cheerlessly. To add to the general sadness, the young queens leave the abode of their youth never to return. I may mention here, that the queen only lives one year. This I proved from several experiments, and it is strange that no previous writer should have considered the length of the queen's life. Whenever I opened a nest, I observed that the queen did not fly away like the rest of the workers. This roused my curiosity. At length I discovered that she was unable to fly, as the tips of her wings had been clipped off. In this respect she resembled one of our domestic fowl. It is said that ants divest themselves in a somewhat similar manner of their wings. Whether the queen,

counts of insects are grossly false. The old maxim, for the reader of RECREATIVE SCIENCE, should be altered, and in future we must read, not "Vox populi, vox dei," but "Vox populi, vox diaboli."*

To observe the habits and domestic manners of wasps, it is necessary that the nest should be conveniently near your house, and also that you should be able to view the combs without disturbing the wasps. Accordingly it is expedient to remove the wasps' nest within a few feet of your habitation, and this may be done in the following manner. Having found a nest about the middle of July, stop up the mouth of the hole with wet mud, so that the wasps outside, who are returning, shall not be able to enter, nor those inside to escape. As each returning wasp comes slowly to the mouth of the nest, knock him down gently with a leafy branch, and then quickly seize him, and put him into a glass tumbler, with a piece of board over it for a lid. For convenience sake, we shall call those wasps who are abroad foraging "mails." In the middle of July there are seldom more than a hundred mails, and these may be all caught in half an hour, which shows that the longest time necessary to procure food is only half an hour. When all the mails are secured, take a small stick, and bore a hole in the soft mud about the size of a wasp. As each of the inner wasps issues through this narrow hole, secure him. When all the inhabitants are captured, then remove the earth from about the cells, and gently lift them into a washhand basin. Then carry the celled wasps home, and place them in a hole six inches deep and as much broad, with some dry moss under them. Let a piece of stick be fixed over the cells in the earth on both sides, to which the wasps may attach their nest. Place a piece of board over the cells, and bore a slanting hole in the ground for the wasps to go in and out. Last of all, empty the tumbler of wasps into the cells. Great care must be taken that the queen be secured, otherwise they will not build. Some sugar should be placed near, that they may feed themselves easily for the first twenty-four hours. It is best to transplant them about six on a *dry* summer's day. The hole should be turned towards the rising sun. Next morning they commence to repair the injuries which the nest has sustained. Their first care is to fasten the combs by a strong pillar to the stick, which, I mentioned before, should be placed contiguous to the cells. Without something to which they may attach their combs, they will not build, because if it cannot be suspended the nest is destroyed by the damp which issues from the surrounding ground. Next morning, I say, they commence to build. Having made this strong pillar, they gradually cover all the combs with a coating of paste. This paste is very beautiful in appearance, and so extremely brittle, that it is difficult to procure a good specimen. It is like a white and red marble. A shell of paste is generally constructed in three or four days. The next business is to remove any dirt which may have fallen into the nest, and any dead grubs. But if any of my readers are fond of recreative science, they will plant wasps' nests, and soon observe all these facts for themselves.

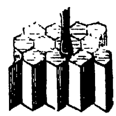


FIG. 4.—Position of pillar.

Having removed the wooden lid, I used sometimes to put a glass globe over the combs, and observe what the wasps did. In this way I acquired a great deal of information. I once admitted a strange wasp into my nest. This excited a great deal of commotion, but he was not killed; and as the wasps could not drive him out, since I had stopped the entrance, they contented them-

* We like plain speaking, and the author is entitled to an unfettered utterance of his opinion; but we must enter our protest against his remark on the popular regard for bees, and his inversion of an ancient motto.—ED. R. S.

selves with placing a guard to watch him. I once inserted a bumble-bee, and though numbers of infuriated wasps attacked him, they did not, or could not, kill him. This leads me to suppose that those stories, which are so popular, of wasps attacking and destroying bee-hives, are groundless. By the advocates of this popular creed, it is argued that every person who has managed bees has seen wasps going into bee-hives. But the fact of a wasp entering a bee-hive does not prove that he eats the honey; and even supposing that he does eat honey, I do not think a wasp would dare to enter a flourishing hive.

The probability, therefore, is, that when damp, or vermin, or some other pestilence, has thinned and dispirited the bees, that then the wasps come in for this share of the plunder; and careless or stupid observers, seeing wasps in the hive, naturally concluded that the wasps had destroyed it. An old lady once informed me, with tears in her eyes, that some wasps, who had built in the thatch of a neighbouring cottage, had destroyed her hives, and that she herself had seen the wasps coming in strong detachments from this. But there were several objections to her statements, because, in the first place, the nest in the cottage was not a nest of *wasps*, but of *bees*; in the second place, the old lady was so blind that she could not distinguish the difference between a wasp and a bee; and, thirdly, wasps do not destroy bees. My poor friend made nearly as many mistakes as that menial who, when showing the roof of the Tower to some stranger, said that it was put up in the time of William the Second, that it was made of Irish oak, and that Irish oak has no cobwebs; but it so happened that it was not put up in the time of William the Second, that it was not made of Irish oak, that Irish oak has cobwebs like any other wood, and that the very roof he was showing was covered with enormous cobwebs.

My brother and I, when boys, had a pet wasp's nest in our bed-room, which we suspended to the ceiling. As the window was constantly open, the wasps thrived; but as the room was an attic, and very low, and as the housemaid was six feet high, and used constantly to knock her head against the wasp's nest and get stung, we were obliged to destroy it. I have always lamented those poor wasps. They knew us as sheep their shepherd, as hounds their master. They never stung me but once; and that was not their fault, as I was showing them to a lady

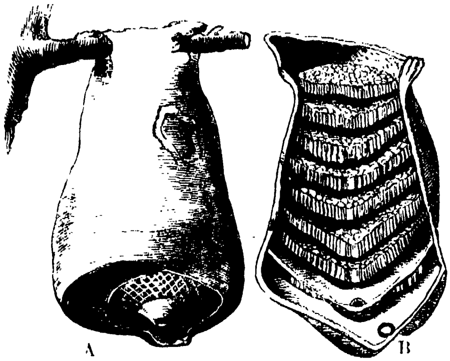


FIG. 5.—Nest of Vespa nidulans. A, exterior; B, section of interior.

in the dark, when they had gone to rest, and could not recognize me. Even a faithful dog will bite if you disturb him at his dinner.

It was, however, disagreeable if they awoke in the night. One night a bat flew in through the window, and landing on the nest aroused all the inhabitants, who came dropping out of their nest in a drowsy state, making a furious buzzing. Still this provoking bat would keep crawling round the nest, apparently wondering what it was. Our beds soon became full of wasps, and I was awakened from my comfortable repose by finding a wasp in my ear! I did not, as may be imagined, remain long quiet, but with my brother rushed madly down stairs.

Another evening, just as my brother was lying down to sleep, I was surprised to hear him emit a loud scream. Upon inquiring the reason, I found that he had lain upon a wasp. It is somewhat remarkable that wasps work after it is dark. When the wasps are just going to bed, a loud buzzing may be heard in the nest.

My brother and I planted four colonies together, with only one common hole; that is, with four minor holes opening into one large hole. They grew magnificently. The wasps, wonderful to say, never mistook their own hole. It was one of the finest nests I have ever seen. One day, some persons, wondering what was under the pieces of board which covered our pet nests, lifted them up carelessly to examine; but as the wasps charged and stung them severely, I fancy they had a very practical lesson against curiosity.

Before I finish I may observe, that my remarks in the preceding pages have been entirely confined to the common ground wasp (*Vespa vulgaris*). The peculiarity of this wasp is that it does not make paper, which the tree wasp, and another ground wasp of a light canary colour, who is not mentioned in any entomological book, do. My observations are merely true with regard to this one species.

And now I have done. I have occupied much space; but if I shall have succeeded in removing the odium under which the wasp unjustly labours, if I shall have pointed out the inexpressible beauty of the contrivances of this little animal, and if I shall have persuaded any of the readers of RECREATIVE SCIENCE to study the domestic habits and manners of these insects, I shall feel amply rewarded. RICHARD L. EDGEWORTH.

Edgeworthstown.

OLD POLL.

SHE's old and gray, very gray, and she exhibits the unseemly vanity of age in wearing scarlet skirts. The spirit of avarice, which is too often a characteristic of age, is but too strongly manifested in her tastes and occupations, for she engages in six different callings, and pursues them all with as much vigour on the Sabbath as on other days. She deals in live soles, old clothes, milk, butchery, bakery, and bonnet-boxes. There is, at least, one more branch of trade she cultivates, and about which she makes many vociferations, but I never could make out the nature of it; for when loudly inviting people to purchase the wares, her utterances are in some foreign tongue—"Kry-i-i-o-o-squau; He-o-o-skay-ark-om; Kreek-ike-oke-um." Whether these sounds are addressed to the natives of Timbuctoo or the Tonga Islands I cannot aver, but I am sure they have a commercial meaning, and imply that there is something to be sold.

A strange character is Old Poll, always in a good temper, always availing herself of the old ladies' privilege to use her tongue, and often in a way not becoming so gray a personage, for she shouts, scolds, and whistles, and rejoices in an uproar. In one respect she has never passed beyond the precincts of infancy, she has never cut her teeth, and, certes, never will. Hence, the chief of her diet is bread and milk, but, strange to say, she likes nuts, and is not above amusing herself by champing up a wooden stick or cotton-reel. She smokes, dances, and laughs "ha-ha." I hear her now puffing away at her pipe—dreadful habit for an aged female. But she invites me to join her—"Will you

mostly dress in green, and red, and gold, and are generally less talkative and less commercial in their tastes. What was her habit of life in her native place, I know not. She was, probably, a wild savage, living in the hollow of a decayed tree, and uttering a language mostly made up of hideous screams, and varied by mocking the voices of people no more respectable than herself. She came to my village six years ago, still ignorant of a single word of our refined English, and her first expressions were those of unmitigated anger and convulsive wrath. She first gnawed into dust the main beam of her upper apartment, and then tore her wigwam, though made of stout steel rods, into pieces. She refused her food, and when spoken to, crouched on the ground, and, in an awfully menacing attitude, gave vent to sanguinary rage. I have tamed too many of these African savages to fear any of them. She was dealt with kindly, but firmly. Not a harsh word was given in exchange for her abuse. She was supplied with hemp-seed, bread and milk, and water; brought into the sitting-room for an hour now and then, and occasionally shut in a quiet room by herself, that she might forget her troubles under the temptation of newly-prepared food. Her rage made her thin for a time, but by degrees she began to perceive the excellence of civilization; she ceased to threaten the hand that fed her, and then of an evening, when she was rather drowsy, and shut in her room quietly, the first lesson in English was attempted by repeating it through the half-open door about half-a-dozen times, and then leaving her to ponder it. The lesson was "Polly, pretty Polly!" While this went on, she was becoming familiar and reconciled, showed delight when the face of her benefactor appeared, and exhibited a docility that was quite touching (remembering her original demonstrations of passion) when food and drink were offered her, after being deprived of both for at least six hours at a time. Robinson Crusoe acted on the proverb that hunger will tame a lion, as you will remember where he tells of his pitfalls for goats: so we subjected our African friend to the starving process, that she might be under no mistake as to whom she was indebted to for nourishment. Now she began to show another sign of being civilized. When all was quiet you might hear her mumbling her lessons to herself; not, however, in a very agreeable manner, for her first attempt resulted in mere gurglings in the throat, as if she were choking. At the end of three weeks from the commencement of the lesson, during which time it had been repeated half-a-dozen times a-day, and always during the process of feeding and cleaning her new wigwam, she began to stammer out, "Pollo," which in a day or two improved to "Polly," and in another fortnight was completed as "Polly, pretty Polly!" Now, I'll tell you a secret about all the members of the family of *Psittacus*—they like to have their heads scratched, and the task is, with a newly-imported savage, to do it; yes, to do it, and keep your fingers sound. Like the burning of the powder in the memorable case of skying a copper, it must be done by degrees; but you will make little progress in taming the savage till you have done that. When getting docile and familiar, turn hunger to account for the experiment. Present a can of food, and as the noviciate reaches forward to get it, give her head a rub with your finger. There is no danger at that moment. In three weeks the pupil will have learnt to like the operation, and through it you obtain a key to her character, and a talisman over her affections. Another peculiarity of these people is a propensity to bite, but those who get bitten generally deserve it, for they never betray real confidence, and meddlesome strangers should learn to abstain from teasing, and poking their fingers in places of danger. But suppose the party *will* bite: Then take it coolly, do not snatch your hand away, bear

the pain patiently. If you resist, there is competition, if you submit, the biter is bitten with remorse, and will follow better ways. I had to lift a young *Psittacus* out of a small receptacle in which she came from shipboard into her proper house, immediately on her arrival not long since. She drew herself up, and growled, and menaced as if she would take my life. But I used my bare hand, grasped her round the waist, transferred her quickly and neatly, and she had my thumb fast between her awful mandibles all the time. I was none the worse for it, but if I had snatched my hand away, the flesh would have torn, so non-resistance was the winner. Thorough familiarity between both parties is the best safeguard against the fear of being bitten, and there must be unlimited confidence. Betray fear in the presence of my old Poll, and if she can get hold of your finger she will imprint her seal upon it; but see here, I open the door of her wigwam, introduce my hand with a kindly coaxing word, and she steps upon it, comes out on my shoulder, and amuses herself by pulling my hair, or whispering among my whiskers. Persevere with kindness and firmness, and you soon accomplish that feat of poll-scratching, and then you have the mastery, and must proceed in the same way to keep it. If from that day forward you make note of any of your friends taking to teasing, or even teaching, remove the pupil out of that friend's way, for no good will come of it. To be familiar with strangers is admirable, and all the members of Poll's family are sociable creatures; but the best part of a seven years' training may be undone in a few days by some trick of biting or growling, or speaking in a nasal voice, taught by a friend for the mere love of mischief.

Now to go on with Poll's history, she began to discard her native speech; she became so fascinated by the English tongu that in less than six months she had given up all her native yells and screams, and was so occupied, whenever left alone for a few hours, in practising by herself, that she deserved to be considered a thoroughly civilized being. Then she was allowed to come to the dinner-table, and to eat and drink as she pleased. Then by degrees she was taught to eat meat and drink milk, two articles of diet she never tasted before. She grew fat and strong. She had a bath frequently, and the confident method was followed of taking her in the bare hands, and sousing her into it; the mistress wiped her dry in her warm lap, and coaxed her before the fire till her garments were in order again. The books say that *Psittacus* should never taste meat, but that is nonsense. We have tamed and taught so many that we can speak without guess on that point; they may, in fact, eat anything if allowed plenty of air, roomy apartments, subjected frequently to the bath, and kept talking for natural exercise.

I may as well confess that old Poll is the favourite, the principal personage in our colony of aliens, and she represents to me the whole of her large family, of which we rejoice in the possession of a moderate gathering of variously habited and variously gifted members. One thing I note as particularly interesting, and that is the high intelligence with which she is endowed, an intelligence shared largely by the rest of the family. There must be some intelligence necessary to acquire a moderate knowledge of another language, and if the act be imitative, I say that the faculty of imitation is not a mean one. But I'll say more: that she understands, and that the well-taught members of her family understand, very much of the spirit of the words they utter, if they do not literally understand their speeches as we do. I cannot forget how, in times when sickness has spread a gloom over the house, Poll has talked in a subdued tone, and for a season restrained her boisterous merriment. Once she went away with her sick mistress as companion, leaving me the troop of white chieftains of

the *Plyctolophus* tribe, the green train-bearers of the *Palæornis* tribe, and the swarm of little zebra, rose-winged, and loving people we had about us then. Poll evidently knew the mistress was not well. She used the tenderest of her speeches, whistled her tunes in a soothing manner, and would come out of her cage and place her gray cheek against the face of the afflicted one in a way to betoken more than a mere familiarity with a benefactress. I observe, also, and all who take to the training of these foreign wildings must take note also, that the imitative faculty is so strong, and acquires such additional force and system by education, that it has scarcely any limits. Poll's business in life is the same as that professed by Socrates—to learn, to learn. The man who goes by with bonnet-boxes was, unconsciously, one of her schoolmasters, but she can never manage the letter X properly; she makes "bonnet-bock" of it. The same with the letter S at the beginning of a word; it is usually rendered as a Y, as in "Supper's ready," which Poll makes "Yupper's ready." At the end of a word, however, the S is no trouble, and so in framing a lesson the pupil may be helped thus, "Is supper ready?" and the distinctness is beautiful. Hard consonants and full-sounded vowels are easiest learnt, as "Lacklanmackachlan," which was the first word uttered by the speaking automaton.

The imitative faculty is observable, also, in the tone of the voice. A person with a weak voice should not attempt such teaching; and for the same reason, where there are people of Poll's kindred, servants should be chosen who have unobjectionable modes of utterance. Poll speaks in at least six different voices. She imitates my voice so distinctly as to be frequently mistaken for me, to the annoyance frequently of the servants, for the gardener has many a time dropped his spade and ran, thinking there was something the matter on hearing the cry, "Quick, quick, come along;" and as for the maid Lucy, she answers to her name faithfully, thinking her mistress calls, and is rewarded with an insolent inquiry or a peal of laughter. But the best thing Poll ever did was to catch the word "Clo" from a wandering child of Israel. She imitates his approaching voice, his passing voice, and his voice going away, and in the exact nasal twang of her gratuitous teacher.

She imitates the flowing of water beautifully; has learnt a few snatches of blackbird and thrush music, and rejoices especially in an imitation of the sparrows, though the chirp is a very large edition of the original. Her friend Pollywoo, who has had but fifteen months' training, looks on with wonder while old Poll goes through these ornithological lessons; but she can make nothing of them herself yet, though she promises to be a remarkably docile and clever bird. By the way, another hint springs out of this; a talking *Psittacus* should have as little of the society of her brothers and sisters as possible; they confuse each other, and the peculiarities of one voice are imitated by the others, without being improvements.

I must notice also, as another evidence of intelligence, the immense jealousy of these people. Jealousy must spring from a sense of self-importance, and however objectionable may be such a feeling, it implies intelligence of some sort. If I were to nurse a baby—and I never had one of my own to nurse, else perhaps I should not have bestowed so much time in training savages—Poll would show by looks and gestures that she would have no division of affections; she dislikes children generally; and of adults, she can pick out instanter those that love animals by the cast of the countenance. If I see Poll make overtures to a visitor, I know that visitor to be open to the soft impeachment of a regard for animated nature. Shall I name one more trait? It is a wonderful memory, combined with a power of classification, for Poll never mixes together words that do not fit. Her

vocabulary includes about forty sentences and verses, more ejaculations and words of greeting than I can pause to count up, and a whole budget of tunes, enough at least for a grand concert. Lessons taught her at the first initiation, and scarcely ever repeated since, are remembered as perfectly as those taught a week ago. She went three years since on a visit, where she learnt the name of a dog, with whom, by the by, she scraped a close acquaintance, and she calls that dog now occasionally, seeming very desirous of a friendly word with Jack. Of course very strange things happen sometimes that would be worth telling if we had place for anecdotes, but we must not venture beyond one. Poll was once visited by a cat; grimalkin looked as if she would like to pick Poll's bones. Poll looked at the cat with one eye sideways, and says she, "Ah, who are you, eh? how are you?" Whereat the cat scampered, no doubt a little astonished to hear plain English from the scarlet-tailed foreigner. She will talk to the sparrows, too, as they creep through the wires of her wigwam to pick hempseeds from her trough. I have heard her coax and kiss them for half an hour together, but sometimes she will change her tactics and make a snap at one, whereat there is a mighty bustle for a moment, and a general clearance of the intruders. She has just seen a leg of mutton pass her on the way to the dinner-table, and she asks in a loud voice, "Is that for Poll?" and presently adds, louder still, "Thank you," in sheer mockery that the savoury treat has disappeared. But she shall have a domino of the juicy lean cut from my plate, and there will be a general silence while she makes her dinner, surrounded as she is by family friends, all equally indebted to the spirit of civilization for knowledge of language and tricks, and all equally engaged in mandibulation, "forty feeding like one."

The reader interested in feathered pets will gather from the foregoing sketch of Old Poll pretty well all that need be said about the management and training of a Gray Parrot. A few more hints may here be useful. The best time of year to make a purchase is the month of August, when a great number of young birds are brought into the country, and sold at prices varying from two to five pounds each. Their first value depends chiefly on form and proportions. A small head, a neat and not bulky body, the cere forming a very clear and distinct patch, the bill well shaped, and the wings perfect, these are the important points to be observed in the purchase of a parrot. No matter whether the dealer like the task or not, insist on seeing the wings of the bird before parting with your money, but allow no amount of scolding and screaming by the bird to determine you against her. There is no middle course between the selection of an untaught bird at a respectable shop and the purchase of a thoroughly-trained bird from a person on whose veracity you can depend. To purchase a parrot of a wandering tar, or of a dealer of whose character you know nothing, is to incur a risk of something worse than the waste of money, for you may be greeted next day with language of an obnoxious sort, and be glad to get the bird out of hearing at any sacrifice.

There is so much amusement in the training and teaching of a bird, that those who have the necessary skill and patience should prefer a newly-imported parrot to the most finished talker and performer. Our parrots are daily supplied with bread and milk and hemp-seeds, and *nothing else*, except occasional scraps from the table; that is to say, they have no water to drink, and no regular supply of dainties. I am an advocate for liberal feeding, for these birds exhaust themselves by their incessant action and the use of their vocal organs, and a poor diet will cause them to lose their feathers and appear dejected. But the appetite should not be pampered, sweets are injurious, raw vegetables very injurious; but nuts,

biscuits, pudding, and fruits are excellent to vary the diet, and keep the birds in health. Meat may be given every day in moderation, that is to say, a slice of cooked mutton or beef without fat, and not more than the bulk of a walnut for each bird, constitutes a good dinner, and is a great assistance in keeping them in fine plumage and bodily vigour. The dreadful habit of picking off their feathers arises through giving them sweets, salt food, excess of hemp-seed, or supplying bread and milk in too dry a state; the bread should be scalded, pressed nearly dry, and be then wetted with sufficient milk to soak it through, and a little over for them to drink; it nourishes, and renders other drink unnecessary. The bath is essential often in summer, occasionally in winter; and to be able to perform the ablution, the birds should be kept in such a familiar state that you can do anything with them.

Gray parrots are subject to numerous diseases, but the causes are always such as are preventible; properly cared for, there is no bird in the whole catalogue of feathered pets more hardy and hearty than these are after the first moult is over. But the first moult is a trial, because the climate and confinement are both new to the bird; it is frequently prolonged during several months, and it is then that they acquire some affection of the skin, which results in a habit of plucking at the feathers, of which it is next to impossible to cure them. Moderate warmth, protection from draughts, occasional meals of the yolk of hard-boiled eggs, are the essentials of management during this first trying moult, and, whenever there are signs of diarrhœa, give a few peppercorns or red capsicums, a few of each of which should always be at hand where parrots are kept. It may be worth mentioning, for the benefit of any of our readers whose parrots are given to the bad habit of picking off their feathers, that *amusement* is a grand specific. Leave the bird to its own resources, and, when tired of talking and whistling, it will begin again to denude itself of feathers, but throw into the cage a short stick with the bark on it, or a wooden cotton reel, or anything of a harmless kind that may be stripped and torn to pieces, and it will forget the hateful habit in the amusement of gratifying the organ of destructiveness. This hint may be worth the whole value of the best gray parrot to many readers who are unfortunately perplexed with the spectacle of a favourite bird hacking itself to pieces. Small cages are a serious injury to parrots, as they prevent the expansion and fluttering of the wings, in which they delight. If a small cage must be used there should be no swing in it, or the bird will lose the feathers from the pinions by frequent contact with it in moving to and fro. I prefer cages measuring not less than 17 inches wide by 28 inches high.

In teaching, great patience must be exercised, and the first lessons must be very short and simple, very plainly uttered, uttered in exactly the tone they are to be repeated in by the parrot, and with a little spirit, such as will be agreeable to others beside the teacher. It is quite painful to hear a parrot chatter in a minor key, or mumble syllables as if it had plums in its mouth. Every accent, tone, gesture of the teacher is acquired with exactitude, and a really clever bird will improve upon and exaggerate them all so as to introduce original elements of her own into all her lessons. It is in the style in which the lessons are appropriated that constitutes the great difference in the respective merits and values of the birds; and the reason why I consider my dear old Poll the best parrot that ever was seen or heard, is because she has certain ways of her own that give originality and comicality to every one of her sentences and antics. A good bird to begin with, and patient perseverance, and there need be no rarity in a parrot talking like a Christian.

SHIRLEY HIBBERD.

THE WATER-BEETLE.

Having been of late studying some of the analogies of natural objects, I was much struck with some peculiarities belonging to the common water-beetle, an inhabitant of pools of stagnant water, known as the *Dytiscus marginalis.* This, possessing much in common with other animals of the order *Coleoptera,* has yet great differences or modifications of structure to fit it for its amphibious life; but the veriest tyro in zoology would not hesitate in placing it in its proper order—Wing-sheathed.

In an excursion after animal life, one cold frosty morning in March, I was fortunate in procuring two specimens of the water-beetle, a larva of the same, three newts, a few boat-flies, and a piece of common duck-weed. Having read of the voracity of the *D. marginalis,* I was determined to verify some of the facts I had seen recorded. Accordingly all the above were placed in an extempore aquarium, constructed of a common propagating glass, covered with a piece of muslin, and filled with water from the pond. In two days the boat-flies were destroyed and eaten; the next morning one of the newts had been attacked, a portion of the tail being eaten; the next day it was dead, and in a few days all the internal organs were destroyed, nothing but a mere shell being left. The remaining newts soon after shared the fate of their unfortunate companions. The larva of the beetle next became a victim to the rapacity of the parents. In short, all was consumed, all fell before their destructive organs. The water was then changed, and some fresh spring-water procured. After a fast of four days, an ounce of roast pork was given to the two beetles; they ate of it greedily, attaching themselves to it by means of their hooked claws and mandibles, occasionally quitting their hold of the food to attack each other; but the cooked meat did not seem to suit their carnivorous propensities, as a few days after they literally sickened and died. Their bodies were then consigned to the scalpel and the microscope, and numerous dissections have since been made of the same species. The results of the various experiments and investigations have been committed to paper, for the benefit of future young naturalists.

The water-beetle, known to the scientific zoologist as the *Dytiscus marginalis,* belongs to the genus *Dytisca.* It has much in common with other beetles marking it as one of the order *Coleoptera,* belonging to the class *Insecta.* An insect is defined by one of our eminent naturalists as an articulated air-breathing animal. To the same class belong the various orders of insects. An insect possesses six legs, thus differing from the *Arachnida,* or spider tribe, belonging to the same division of the animal kingdom, the *Articulata.* An insect, then, has six legs; this property marks the class. The order *Coleoptera* has four wings, the upper two being modified from true organs of flight into a covering for the true wings, serving to protect them from too rough contact with hard substances. The true insect breathes by means of tracheæ; this property is common to the insect world. Its body consists of an external skeleton, composed of an animal substance termed "chitine," serving as points of attachment for the various muscles in the order *Coleoptera.* This is usually very dense; the body externally is divided into three portions, the head, thorax, and abdomen. In some tribes the head and thorax seem united; in some genera of beetles this is the case.

The common marks of the beetle tribe, then, are the possession of six legs, a body

divided into three parts, four wings, the upper two being horny. Breathing air, these common marks may be and are much modified in some genera, so much so that the young student of natural history would feel in doubt in which order he should place an animal found by him. No such doubts can assail him with the great water-beetle (Fig. 1). I will now proceed to show the

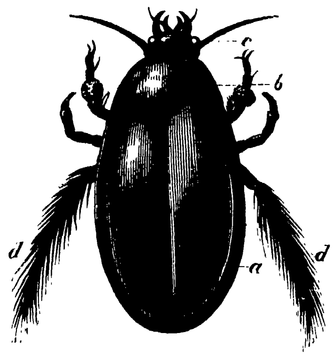


FIG. 1.

marks by which it may be known, and, after reviewing the animal as a whole, will take a survey of its various parts. To do which, it is necessary to examine separately three distinct systems, namely, the respiratory, the nervous, and the digestive systems.

The great water-beetle, a common inhabitant of stagnant water, is a large, fierce insect, which might with propriety be styled the crocodile of insect life. Its usual length is about 1$\frac{1}{10}$ths of an inch, oval in shape, having its body divided into three distinct parts. *a* (Fig. 1) represents the abdomen; *b*, the thorax; *c*, the head, the head and thorax being closely united. It has three pair of legs; the posterior pair, *d*, are lengthened, so as to form a pair of powerful paddles, concave on the inner side; the middle pair furnished with no peculiarity; the anterior pair have a powerful sucker, or rather series of suckers, at the end of the tibia. The thorax bears two pairs of wings, about one inch in length when expanded in the act of flight, but folded back upon themselves, and covered by the elytra, when at rest. The head carries the jaws, the antennæ, and two compound eyes. The usual colour is a dark violet, fringed on the upper side by yellow bands; on the under side the prevailing colour is yellow, edged with a dark band on each segment. By these general marks the creature may be known.

We will now proceed to the respiratory system, and view it by the aid of the microscope. As before stated, all insects breathe by means of tracheæ, lungs not being found in any of them; and our present subject is no exception to the general rule. The tracheæ are numerous minute tubes, communicating with the outer air by means of openings termed spiracles, or stigmata.

One of these, magnified 200 diameters, is shown at Fig. 2. The narrow mark along

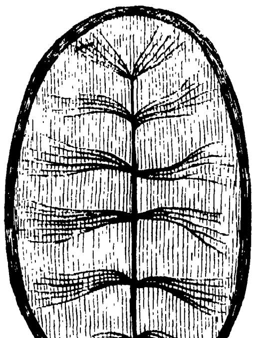


FIG. 2.

the centre is the opening of the tube. This can be closed at the pleasure of the animal, by means of powerful muscles, shown in the figure; a dark muscular band also runs round the edge of each spiracle, and on the inner side may be seen numerous muscles laying in parallel bands. There are twelve of these spiracles, one on the upper edge on each side of the abdominal segments. To see

them the operating microscopist must remove the elytra and wings; he will then perceive the upper side of the abdomen is covered with a soft skin, on the edge of which the spiracles may be seen as minute dots. Each of these stigmata communicates with tubes, one of which is shown at Fig. 3. These

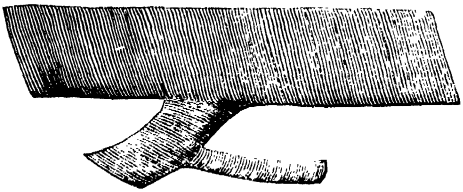


Fig. 3.

breathing vessels bear a close analogy to the spiral vessels of plants, but in the insects the coil of wire is inclosed between two membranes; this coil serves the purpose of keeping the tube distended, otherwise it might collapse, and the suffocation of the animal would follow. The beetle passes the greater part of its life in the water, but possesses the breathing apparatus of a land insect, therefore air is necessary to its existence, to obtain which the creature is frequently obliged to ascend to the surface to breathe. This it does naturally, as its body, especially the abdomen, being specifically lighter than the water, it can only be kept submerged by the action of its paddles; as soon as this ceases it rises, the abdomen appears above the water, and the air flows under the elytra and wings to the stigmata.

The tracheæ ramify to all parts of the body, and may be traced in the legs, the antennæ, and the elytra, when the last is made sufficiently transparent. The purpose served by this distribution of the air is to bring the blood in every part of the body into close contact with it. As insects possess no true heart nor system of veins and arteries, as the higher animals, the only representation of a circulating system is found in the dorsal vessel, a kind of heart (Fig. 4) divided into several chambers, in which the blood is made to flow only in one direction; the contrary motion being prevented by valves from this vessel, the blood passes into the general system, unconfined by any vessels, and is then brought into immediate contact with the thin covering of the tracheæ, and thus becomes aerialized. The nervous system of the beetle is well developed, and when we consider the size of the nerves, and reflect that they are the agents by which ideas are conveyed to the mind, and also the carriers of impressions from the external world to the sensorium, and the bearers of despatches to the limbs in obedience to the will of the monarch mind, we should expect to find an animal so carnivorous in its habits to be well supplied. Fig 5 gives the general structure of the nervous system of an insect; *a*, is the cephalic ganglion; *b*, the thoracic, *c*, the abdominal ganglia. From *a* are given off branches proceeding to the eyes, the optic nerves; these are subdivided, one going to each lens, the eyes being compound with hexagonal lenses; by placing a drop of nitric acid on the slide with a portion of the eye, the lenses are coloured a dark brown, and the shape easily seen. Other branches go to the antennæ; indeed I believe these to be essentially organs of touch. They must be soaked for some time in turpentine, and then viewed by polarized light. The nervous system communicating with numerous stiff hollow bristles, may be thus plainly seen. Branches are also given off from the cephalic ganglion to the maxillæ, which I will speak of with the digestive apparatus. From the thoracic ganglion branches proceed to the wings, the elytra, and the legs; the abdominal ganglia are smaller than the others, but one

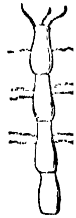


Fig. 4.

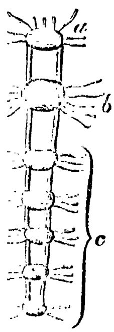


Fig. 5.

is found in each segment save the last. Each ganglion is connected with its fellow by means of a double cord of nervous matter. The digestive apparatus is decidedly the most important to the insect world, as it is the one to which both the other systems are subservient, all the occupation of the animal consisting in eating and reproduction. In a creature so rapacious as our subject we should expect to find this system perfect; indeed, to look at the perfect mouth, so well developed, leaves not a doubt of its habits, but when we find the powerful jaws, coupled with a dilatable crop, a powerful muscular gizzard, a short stomach, and a short intes-

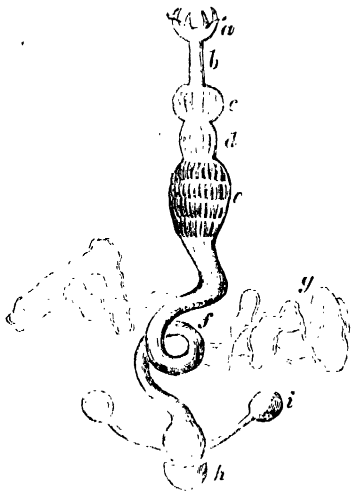


FIG. 6.

tine, no doubt remains. Fig. 6, *a*, represents the jaws; *b*, the gullet; *c*, the crop; *d*, the gizzard; *e*, the stomach; *f*, the intestines; *g*, the liver; *i*, organs of reproduction, found only in one sex; *h*, the cloaca. Round the true stomach, *e*, are numerous follicles, or hair-like appendages, secreting gastric juice. The short intestine having but one convolution marks the animal nature of its food. Let a tadpole or other small herbivorous animal be opened, and the intestine will be found twisted in numerous convolutions, which may, sufficient care being exercised, be drawn out to many times the length of the animal. No true liver exists in the lower animals, therefore we must expect to find none in the water-beetle. It is highly probable that the liver of the most complex organization consists of a number of minute tubes, but too closely connected in the higher animals to be separated. Descend lower in the scale of creation, and you may find rudiments of tubes secreting bile; as in this animal there are, just below the stomach and opening into the lower part of it, a long tortuous tube on each side. On applying Pettenhofer's test to the contents of this tube, the fluid was decidedly red, and must have been bile. Here, then, is the representative of the liver.

To enable the animal to secure its prey, frequently many times its own size and much stronger, some apparatus is requisite to enable it to attach itself and feed securely, and we find it not unprovided. It was mentioned, in the description, that the anterior pair of legs were furnished with a pair of suckers, or rather a series of suckers. Let us bring these suckers to the test of the microscope: having previously bleached them in chloride of lime, we shall then find the apparently round sucker to be composed of two joints of the tarsi or foot. The three basal joints are expanded laterally, and form a broad shield covered with discs: these discs are the suckers; they number several hundred,

FIG. 7.

the larger ones appearing as conspicuous dots at the base of the aggregation of smaller ones. Fig. 7 shows the suckers magni-

fied twenty diameters; with that power it can be seen that each of the small dots are furnished with a hair-like appendage. Fig.

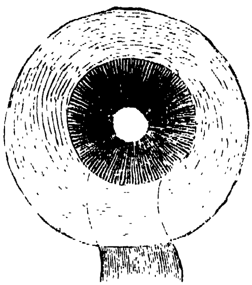


Fig. 8.

8 shows one of these minute dots magnified eight hundred diameters; it is then seen to be a complete sucker surrounded by a de-

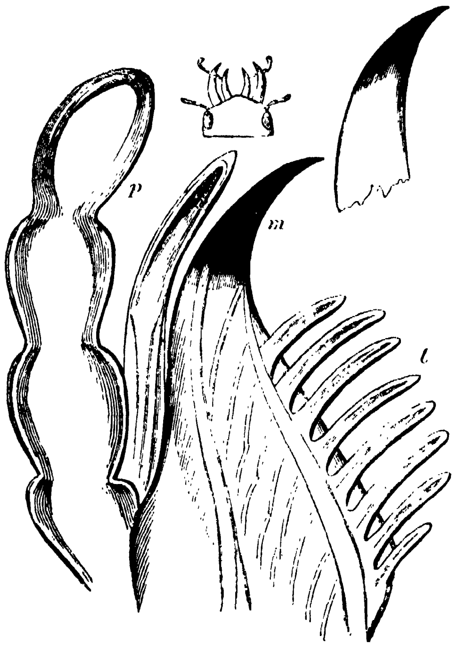


Fig. 9.

licate membrane and seated on a footstalk capable of movement, thus enabling the animal to dart on its victim and fix itself securely. While satiating its appetite it even attacks small fish, and all fly from its presence with dread. The structure of its jaws is perfect, and a more terrible weapon of attack on a small scale can scarcely be conceived. After securing itself by the powerful suckers, the mandibles (Fig. 9) are plunged into the body of its prey. In vain are all its efforts to free itself from death.

These mandibles are hard as iron. Some idea of their density may be formed from the fact that, after soaking three weeks in strong liquor potassia, they were not softened. They are stout in proportion to their length. The maxillary palpi (Fig. 9, *p*) are then at work feeling for the vessels in the body of its victim. These palpi are delicate organs of touch, being completely filled with a nerve communicating with the cephalic ganglion. The tip of the maxilla is also very dense (Fig. 9, *m*), and along the inner edge of each are numerous strong hollow teeth (Fig. 9, *t*), communicating with channels leading to the gullet. To see these with the best effect, bleach the maxilla in chlorine a few days; examine it with an inch object-glass and polarized light. The different structure of the tip of the maxilla, the hollow teeth and the channels beneath the surface, are beautifully brought out. If the selenite stage be used the play of colours as the rotation is made is exceedingly beautiful.

Here, then, is an insect, terrible in its own little world, and one possessing the same habits in both active stages of its existence; the larvæ being as rapacious as the fully developed insect. And how beautifully adapted are the means to supply all its wants, and such we shall find to be the case in all the works of the great Creator of all things. He who can alone create so perfectly must be perfect Himself.

Sheffield. W. F. Cooper.

WAYSIDE WEEDS AND THEIR TEACHINGS.

HANDFUL V. CONTINUED.

From the leaves and flowers which have hitherto formed the subjects of our botanical lessons, we naturally look to the stems by which both are supported. By stems we do not mean the peduncles and petioles. We trust our readers have not forgotten that these are but the main stem or axis which forms the plant centre, and from which flower-carrying peduncle and leaf-supporting petiole alike spring; with the stem, too, we by consequence connect the root, and treat of both together. Were we to ask our novitiate readers what parts they would consider most necessary for the existence and individuality of a plant, they would be much inclined to name root and stem, and yet there are plants apparently destitute of one or other of these parts. Some of the orchis tribe have no roots at all, except such as are air planted, or aërial, and the familiar primrose, the plantain (Fig. 52), the stemless thistle, etc., etc., seem equally destitute of stem. Seem, be it remarked, for no plant which bears a leaf can be said to want a stem of some sort, be it ever so short, no more, perhaps, than what is called the root crown, but still it is stem, for though so intimately connected, the two parts claim to be essentially distinct from the first moment of their seedling birth, when the root *will* go down, and the stem *will* go up as by most unerring instinct. If any reader could tell us why all roots tend to strike downwards, away from the light, and towards the centre of this terrestrial ball of ours, they would answer a very puzzling question. Many experiments have been tried, and germinating seeds have been placed in all positions and, circumstances, but yet down go the roots, up go the little seedling stems, and all we can say is that so it has been ordered by God.

Of stems we have many varieties; you have only to use your eyes in the first walk you take in field or garden to learn that. This green stalk of groundsel, or of chickweed, or even the young shoot of rose, bramble, or honeysuckle, breaks off easily enough in your hand, and gives you a specimen of the herbaceous stem, but try some of the older second year's growths of the last-named plants, and you find them tough enough, they are no longer herbaceous, but woody. You have here a practical example of the two kinds of stems and plants; the first herbaceous, green, succulent, and easily broken, such as are formed by one summer's growth; the second, brownish, tough, and woody, such as we find in shrubs and trees of two or more years' existence. Between the well-marked herbaceous stem of the quick-growing weed, and the hardened heart-wood of the oak, we have, of course, every grade of distinction.

Compound or branched stems, and simple stems, give us another division. The first are so common, and comprise such a large proportion of our trees and shrubs, that to cite example would be superfluous; as to the latter, the grasses, such as wheat, rye-grass, the sedges, etc., give us good examples, and the common foxglove, amid others, an excellent one. The simple unbranched stem which supports the head of the dandelion, the umbel of the cowslip, or the spike of the plantain, and which is known as the scape, is more properly a peduncle than a stem. In examining compound or branched stems, it will be as well to note that plants which have

their leaves placed alternately, as a rule, give off alternate branches, and *vice versâ*: and having already learned that branches take their first commencement from buds in the leaf axils, this is no more than we might expect. Having drawn your attention to the simple stem of the grasses, known as the culm, we must bid you remember the division of vegetables to which the grasses belong—those with one-lobed seeds and straight-veined leaves, but which also bear the name of endogenous plants from the peculiar mode of growth of the stems, which have their annual additions of new material made to the centre. This mode of growth we cannot see exemplified in the herbaceous grass, or indeed in any of our native endogens, but the giant palms of the tropics, could we get at them, would show not only this peculiar stem structure, but the noblest specimen of the simple, unbranched stem. Call to mind the pictures you have seen of some palm-clad island of the Southern Seas, and you will remember the simple stem of these beautiful and stately trees. To return to the grass stem (Fig. 87), examine it further. It is hollow, hence called fistulous; its hollow column, strong in itself, considering the amount of material, is further strengthened by knots or thickenings, at which a partition or diaphragm is thrown across the

FIG. 87.—Portion of culm of a grass which is hollow or fistulous: *a*, leaf, which at *b* forms a sheath for the stem or culm; *c*, knot, where the stem is divided by strengthening partitions. A, culm split, to show at *c* the knot or diaphragm.

tube (Fig. 87, A). Moreover, the exterior of the green grass tube is smooth and shining from its coating of silex. A wonderful combination of strength, lightness, and slender grace have we in the simple grass stems. The sedge of the water-side has also a simple stem and straight-veined leaf, but the stem is sharply triangular (Fig. 88), and has no knots. We go back to stems generally; if we want an

...—Section of Stems: *a*, round, as in the majo... of plants: *b*, furrowed, as in many umbel... ...ers; *c*, compressed, as in flat-stemmed ...dow-grass; *e*, angular, as in common wall... ...ower; *f*, triangled, as in sedg...

erect stem, this upright meadow ranunculus or buttercup gives us an excellent example, but for that matter we need be under no difficulty in finding many a wayside weed, which stands as erect as any volunteer rifleman. The reverse of upright we find in many another wee plant. The ground ivy which shows its bright blue blossoms under every hedgerow in early spring, rests its procumbent or flat-lying stems on the ground; and almost similarly placed we find those of the ivy-leaved speedwell, in which, however, the decumbent stems gradually merge into ascending ones. The decumbent stem does not rest so completely on the ground as the procumbent one. The prostrate, or trailing, or creeping stems, such as we find in the common yellow moneywort, root at various points as they go on, in a different way, however, from the long weak runners, or branches of such plants as the strawberry, the common creeping butterfly, or our example the creeping cinquefoil. These runners carry at their extremities buds or scions, which rooting, form new plants, and these, in time, become

the bird'-nest orchis (Fig. 93), is simply a tuberous root, only the tubers are long, thin, and numerous, instead of thick and limited

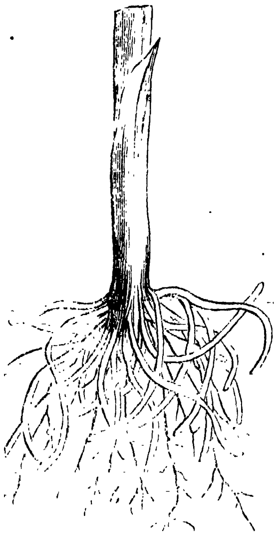


FIG. 93.—Root of Bird's-nest Orchis: *a*, fibre-l:k s; *b*, fibres or 1

in number. The last roots we have to speak of are the aërial; we do not mean roots like those of the well-known banana, made still better known by Moore's lines, or of the tropical orchids; but rootlets such as the ivy throws out to the wall against which it clings, using them as supports, but ready also to connect them with rootlets should occasion offer.

We need scarcely tell our readers that roots (except the aërials) serve first the purpose of fixing the plants to which they belong to the soil, and, secondly, that of absorbing moisture along with gases and salts for the nourishment of the plant. This absorption is effected not by the whole root surface, but by the extremities of the fibres or rootlets, these extremities forming what are called spongioles; or, in other words, being so constructed as to admit of more ready absorption of the nutritious fluids. Lastly, a few words are requisite respecting those fleshy masses which we have, for the first time, met with in the form of the turnip or the radish root, the tuber of the orchis, the corm of the crocus, etc. What is their intended use? They are simply stores of nutriment laid up for aiding the future growth of the plant itself, in its flowering and seeding, or for the nutriment of a new generation of younger plants. Throughout the vegetable kingdom we find this providential storing up for future use often in the root, but sometimes in the stem, as in the crocus, the fleshy scales of the lily bulb, or the actual stem of the turnip-stemmed cabbage; or, as in the well-hearted cabbage itself, in the leaves. Perhaps our readers have never reflected why a cabbage hearts, or a turnip forms its globe, or a carrot its long fleshy cone; they will not now forget that He who "opens his hand" and "fills" all "with good," thus doubly provides for the well-being and food of man, and for the due development of his "lower works."

SPENCER THOMSON, M.D.

DESSICATED MILK.

In this age of inventions we may regard those as really beneficial which supply a positive want, and do not merely obviate an inconvenience, or are only auxiliary, or helps, to that which, after a fashion, is already compassed. Of this class I take the above ingenious discovery to be, and it is, therefore, worthy to be known and talked about. Milk, as it is naturally taken, never is exposed to the air, for the young animal imbibes it

directly from the mother; when, however, it is drawn for man's use, and stands exposed to the atmosphere, it undergoes a considerable change, and produces what is called lactic acid, which, from continued exposure, so predominates that the milk becomes what is commonly called sour. Milk is composed of *serum*, or whey, and a coagulable substance called *caseum*, or curd; besides which it is filled with globules of fatty matter called cream, which being specifically lighter than the other component parts by which they are held in suspense, upon either being agitated, or by the change which the atmosphere produces upon the *serum* and *caseum*, rise to the surface, and are then skimmed off, as we all know. Of course, each of these globules, which individually are exceedingly minute, has adhering to it a portion of the whey, or *serum*, and it is by dislodging this that by degrees the globules adhere together and form butter, and this is done by subjecting them to a violent action by churning. In winter these globules contain a great admixture of *serum* and *caseum*, and the milk is what is called poorer than in summer, and the consequence is that a longer time is taken to get rid of it, and enable the globules to adhere, and hence butter comes, as it is termed, quicker in summer than in winter.

In making cheese a powerful acid is used, usually calves' rennet, or stomach-lining, which divides the *caseum* from the *serum;* and the former with the globules of fatty matter, if it be new or fresh milk, or with their number greatly reduced if it be skimmed, is rid of the latter entirely by pressure, and becomes cheese.

It is necessary to refer to these operations to conduct us to the process we are to consider. The *serum*, or whey, which is in fact the watery part of the milk, contains also the saccharine matter, and in some milk the pure sugar of milk bears a very large proportion to the whole mass. Now, of course, taking milk, as I have said, in its original form as it is secreted, it is pure cream, curd, water, and sugar, besides some salts, which form naturally and chemically component parts of these. For the purpose of preservation, therefore, it is necessary, as far as art can accomplish it, to get rid of those portions which may tend to decompose it, and retain those which are found essential to its formation, or, if you cannot retain them, to substitute something in their stead. Accordingly, we find in the ingenious invention which I am going to describe this principle carried out. To those who have taken a voyage to India; to the South Sea whaling adventurer; to those, who, for months and almost years together, have not known what *terra firma* was, I need not speak of the luxury of those things which we regard as mere necessaries, mere adjuncts to our daily life, which come to the dweller in the great town, he scarcely knows how, except that with the most limited means they are obtained at an easy rate. Milk certainly comes under this category. The sea voyager of old times, nay, even of modern times, will tell you what an object of interest were those square green houses on deck, out of which a solitary and melancholy cow looked out upon the tar-smelling and creaking scene, and what a sinking of the heart it caused to many when the report became rife that the cow was *dry*. Poor thing! no longer looked to as the source of comfort by the mother or father, but an incumbrance to be thrown overboard, perhaps, in the first rough weather, unless otherwise disposed of, for fresh meat is next to fresh milk. For many years, in ships tolerably appointed, preserved meats in hermetically sealed cases have been common, but the idea of always having fresh milk was left to modern times to realize. On the 25th of November, 1848, Felix Hyacynthe Folliet Louis took out a patent for cows', goats', and asses' milk, preserved in cakes, and soluble in warm water, and capable of being kept for a length of time. The

the bird'-nest orchis (Fig. 93), is simply a tuberous root, only the tubers are long, thin and numerous, instead of thick and limited

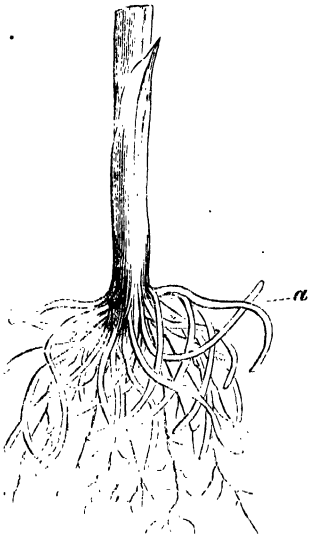


Fig. 93.—Root of Bird's-nest Orchis: *a*, fibre-like tubers; *b*, fibres or rootlets.

in number. The last roots we have to speak of are the aërial; we do not mean roots like those of the well-known banana, made still better known by Moore's lines, or of the tropical orchids; but rootlets such as the ivy throws out to the wall against which it clings, using them as supports, but ready also to connect them with rootlets should occasion offer.

We need scarcely tell our readers that roots (except the aërials) serve first the purpose of fixing the plants to which they belong to the soil, and, secondly, that of absorbing moisture along with gases and salts for the nourishment of the plant. This absorption is effected not by the whole root surface, but by the extremities of the fibres or rootlets, these extremities forming what are called spongioles; or, in other words, being so constructed as to admit of more ready absorption of the nutritious fluids. Lastly, a few words are requisite respecting those fleshy masses which we have, for the first time, met with in the form of the turnip or the radish root, the tuber of the orchis, the corm of the crocus, etc. What is their intended use? They are simply stores of nutriment laid up for aiding the future growth of the plant itself, in its flowering and seeding, or for the nutriment of a new generation of younger plants. Throughout the vegetable kingdom we find this providential storing up for future use often in the root, but sometimes in the stem, as in the crocus, the fleshy scales of the lily bulb, or the actual stem of the turnip-stemmed cabbage; or, as in the well-hearted cabbage itself, in the leaves. Perhaps our readers have never reflected why a cabbage hearts, or a turnip forms its globe, or a carrot its long fleshy cone; they will not now forget that He who "opens his hand" and "fills" all "with good," thus doubly provides for the well-being and food of man, and for the due development of his "lower works."

Spencer Thomson, M.D.

DESSICATED MILK

In this age of inventions we may regard those as really beneficial which supply a positive want, and do not merely obviate an inconvenience, or are only auxiliary, or helps, to that which, after a fashion, is already compassed. Of this class I take the above ingenious discovery to be, and it is, therefore, worthy to be known and talked about. Milk, as it is naturally taken, never is exposed to the air, for the young animal imbibes it

directly from the mother; when, however, it is drawn for man's use, and stands exposed to the atmosphere, it undergoes a considerable change, and produces what is called lactic acid, which, from continued exposure, so predominates that the milk becomes what is commonly called sour. Milk is composed of *serum*, or whey, and a coagulable substance called *caseum*, or curd; besides which it is filled with globules of fatty matter called cream, which being specifically lighter than the other component parts by which they are held in suspense, upon either being agitated, or by the change which the atmosphere produces upon the *serum* and *caseum*, rise to the surface, and are then skimmed off, as we all know. Of course, each of these globules, which individually are exceedingly minute, has adhering to it a portion of the whey, or *serum*, and it is by dislodging this that by degrees the globules adhere together and form butter, and this is done by subjecting them to a violent action by churning. In winter these globules contain a great admixture of *serum* and *caseum*, and the milk is what is called poorer than in summer, and the consequence is that a longer time is taken to get rid of it, and enable the globules to adhere, and hence butter comes, as it is termed, quicker in summer than in winter.

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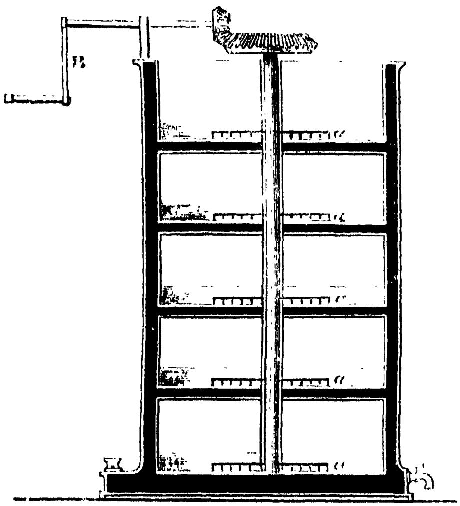
principle upon which this was done was equally ingenious and simple. To every twenty parts of whey one part of bicarbonate of soda, or alkali, was added, and a quantity of clarified raw sugar, which, being evaporated by placing the curd over a slow fire, produced a solid mass, which was formed into hard cakes, and fit for preservation and use. This curd was obtained in the usual manner by turning the milk. This was the simplest mode, but that for which the patent was chiefly obtained was as follows:—Three or more metal circular pans were fixed one above the other, having a chamber or double bot-



tom beneath each, communicating with three upright hollow posts or standards, which were closed at the top, but communicated with a hollow reservoir at the bottom of each and all, into which a valve at one side admitted steam from any convenient source, which was let out by a tap, when requisite, at the other. Through the centre of each pan, from top to bottom, was also a post or standard, with water-tight collars where it ran through the pans, to which was fixed in each pan a cross piece or rake with teeth; and a common toothed wheel being attached to the top of the centre standard, and worked by a lateral one fitting into it at right angles, and turned by a handle, a motion was obtained by which the rakes revolved in the basins, and caused the proper amount of agitation required during the evaporation caused by the heat of the steam. The accompanying figure is a section of the apparatus, the dark portions being the chambers occupied by the steam. The rakes, *a a a a a*, being constantly kept in motion by turning the handle B, the steam being kept at from 170° to 199° of Fahrenheit. When the mixture is reduced by this process to a hard mass, it is then evaporated by the action of the atmosphere, and being then in the form of hard cakes, is ready for use, and by the admixture, as I have before said, of warm water, milk may be obtained as nice, and for all purposes as good, as ordinary milk.

Not long since Thomas Shipp Greenwade took out a patent for an invention somewhat similar to the above, the only difference being in the mode of preparation, and that the cakes, when hardened, were crushed, powdered, and bottled. The agents employed in evaporating and preparing is hot water instead of steam, and the pan with a double or false bottom is larger and square, with a crank and quadrant beneath, which, being connected with any motive power, acts as the jogger does in a corn-cleaning machine, and keeps the machine constantly in motion, and its contents, therefore, in constant agitation. This apparatus is, in fact, nothing more than a square tank resting upon gudgeons, instead of the number of circular pans in Louis' invention. In practice, this latter would probably, in many respects, answer better, as it is evaporated by heat, and not by the atmosphere, as in the other case; a larger quantity of sugar, and that refined is used, and the invention is also capable of being applied to scalded milk; but the greatest advantage it possesses is the form in which it is fit for keeping and use, namely, in glass bottles,

sealed and stopped close, and in powder. Now it must be obvious that a tea-spoonful of powder mixes much more readily than a hard tough lump; for, of course, the substance is very tenacious, and a bottle would also probably preserve it much better. I have attempted a short description of this clever invention, the merit of which is, no doubt, equally due to both patentees, the later invention being now worked by a company (limited). The term "desiccated" means only dried; and for the use of ships, especially emigrant ships, where there are so many children on board, it must be a great desideratum; the price also is exceedingly moderate, scarcely exceeding that of ordinary milk. If the flavour and effect upon tea and coffee are not precisely the same as new milk, it detracts nothing from the utility of the manufacture, inasmuch as a good substitute for the genuine and fresh article is all that can be expected; and this it certainly is. O. S. ROUND.

WHY DO WE LIE DOWN TO SLEEP?

"Come with thine urn of dew,
Sleep, quiet sleep, yet bring
No voice, love's yearnings to renew,
No vision on thy wing.
Come as to folding flowers,
To birds in forests deep,
Long, dark, and dreamless be the hours,
Oh! gentle, gentle sleep."

MRS. HEMANS.

THE universe is a system of cycles. Its phenomena have the characteristic of constant recurrence. Each cycle comprehends some other cycle, and they are all comprehended in the great Eternity, the only cycle of God. The periods of day and night, the revolutions of the moon, the nutation of the earth's axis, the precession of the equinoxes, the seasons of the year, are all cycles relating to and depending on each other! This law obtains in man's being. The periods of infancy, youth, adolescence, manhood, and decay, are cycles contained within the one of individual life. Individual life is a cycle contained within the greater cycle of the aggregate life. This law obtains also in the phenomena of mind, and is, in fact, the sustaining of the mighty fabric of the universe, which flows and ebbs within itself. The conditions of sleep and wakefulness constitute a cycle coincident with the cycle of day and night. LIGHT—Wakefulness, vigour, activity, life. DARKNESS—Sleep, torpor, quietude, repose, temporary death. The great law of duality prevails here as in every pulse-throb of the created scheme.

What is life? Life has been defined by Stahl as that which prevents decomposition (*putredim contrarium*). Life is the result of organization; the result of the assemblage of organs and functions, and of their mutual exercise and co-operation. Physical science enables us to educe the laws of vital action. Chemistry and physiology work hand in hand in unfolding the mysteries of life's multiform wonder-work. Physiology and chemistry are tied together by a gordian knot. To attempt to sever them would be like the attempt to utter an oration with a severed tongue, or to wander and grope in the mazes of conjecture with hoodwinked eyes. The scalpel and the alembic must henceforth go together, for the days of research in *pure* physiology are behind; there-

fore we shall not solve the problem before us by an appeal to physiology alone.

Matter exists in two great divisions: Organic matter is governed by physical laws, attraction, chemical affinity, etc.; it has physical properties, as cohesion, elasticity, etc. Living matter is *subject to* physical laws, but with modifications. Organization, vital properties, functions, and life are expressions related to each other. *Organization* is the instrument, *vital properties* the acting power, *function* the mode of action, and *life* the result. All questions concerning the manifestations of vitality are questions of mystery; the mode of action cannot be made a subject of direct experiment, we cannot get to the function while the life is there. While the manifestations of life may be *inter se* identical, their outward characteristics differ. The herbivora maintain the temperature of their bodies by the unceasing destruction of the carbon of the blood. This is derived from their food, and by the respiratory process it is brought into contact with the oxygen of the air, and the consequent burning of charcoal produces a temperature above that of the surrounding medium. In the carnivora the blood does not supply a sufficiency of carbon, and the vital tissues themselves are destroyed to maintain life. Oxygen *will* destroy the organic fabric, and the deficiency of carbon in the blood of the carnivora permits it to attack the muscular fibre, and that is constantly burning away to maintain the animal heat. This chemical fact explains the spare outline of their bodies, and the small secretion of adipose tissue; it also explains the fœtid exhalations which pass from them, and which are the result of the rapid decomposition of nitrogenous principles, and the consequent production of a considerable volume of ammonia and other proximate compounds. The human body is kept at a temperature of 98° Fahr. by the constant desfruction of carbon. If the diet consists of starchy or carbonaceous materials, such as farinaceous food, the action is the same as that of the herbivora; if flesh forms a portion of the diet, muscular tissuo will be decomposed to a greater or lesser degree, and the nitrogenous principles will cause the evolution of odours similar to those of the carnivorous tribes.

In the economy of the human frame, the vital organs and their corresponding functions may be grouped into two great classes the voluntary and the involuntary. The voluntary are those which act conjointly with the will and in obedience to it, as the motor nerves of the muscular system; the involuntary are those which act independently of the will, as the lungs, the stomach, the heart. The heart continues to beat at the rate of a hundred thousand times every twenty-four hours, for eighty or ninety years, whether we will that it should do so or not. The muscular system is under the control of the will; you may raise your arm or let it rest as *you* please.

Volition forms the great distinction between animal and vegetable life; as vegetables are without volition, their functions are constantly increasing the fabric; and when volition ceases in the animal, its life approaches to a vegetative state. Our organs of digestion and assimilation are beyond the control of the will, and therefore nutrition may be considered a vegetative process.

The prominent characteristic of sleep is the suspension of volition: the state of an animal during sleep is, therefore, analogous to that of a vegetable. The vital forces are not constant and uniform in action; they are ever ebbing and flowing like the tidal waters of the sea. The most important physiological distinctions, between wakefulness and sleep are the diminished respiration and slower circulation during the latter state, than during wakefulness. It is a law, that after the lapse of a certain number of hours of activity, the involuntary organs, the heart and lungs, lose their wonted activity, and their action suffers

a diminution. The body must be passive and in a recumbent position, in order to induce sleep with ease, and to secure its benign influence. The contraction of the heart is the power by which the blood is propelled into the system: the contractile force is adequate to propel the entire current through the circle. The heart of the horse has a force capable of maintaining a column in an upright tube of ten feet. A column of ten feet indicates a pressure of about four pounds and a half on each square inch of surface. Allow that the human heart is capable of supporting a column of eight feet, a pressure of about four pounds to the square inch will be indicated. But the left ventricle must exert a greater power than that which is merely necessary to propel a given quantity of fluid a given distance: it has to overcome the resistance of the quantity of the blood projected: of that which is already in the artery, and which does not partake of the immediate propulsion, and also of the elastic vessel: so that a force of about six pounds on the square inch is the most satisfactory estimate. The left ventricle, when distended, has about ten square inches of acting surface, and therefore we estimate the total mechanical force of the heart at sixty pounds. Dr. Hales estimated it at fifty-one.

Now, while the body is maintained in an upright position, there is a column of blood reaching from the heart to the head, acting upon the propelling organ; this is equal to a pressure of five pounds upon the heart. But, by assuming the horizontal position, this distending force is diminished; therefore the heart relaxes, and the blood flows more slowly through the system. Of course it comes less rapidly in contact with the heart and lungs, and these are also diminished in their action. And then the amount of arterial blood in the body becomes less, and, consequently, the amount of venous blood greater.

Thus we see that one of the physiological conditions of sleep consists in a lower degree of vitality, consequent on the slower circulation of the blood.

When the aorta (that is, the great artery arising out the left ventricle of the heart) is tied by a ligament, sleep is the result. When large quantities of blood are removed from the body, sleep invariably follows. When venous blood is withdrawn and injected into an artery, sleep takes place, amounting to asphyxia, and sometimes to death. Bichat believed that this resulted from the mere presence of venous blood in an artery; Dr. Kay Shuttleworth has shown that it may result from increased pressure on the brain. In either case this experiment throws light upon the subject. Reptiles have a great tendency to sleep, while birds are remarkably wakeful animals. The circulation in the reptile is slow and sluggish; hence the low temperature of the body and the tendency to a state of torpor. The circulation in the bird is exceedingly rapid, the vital forces are more energetic in action, and the opposite condition is the result. Chossat found that frogs would live for fifteen months without food, and with a very trifling loss of weight; nay, he found that frogs would continue alive for a considerable length of time in a vacuum.

We have seen that the blood flows more slowly through the system during sleep, than during wakefulness. The result, then, of this difference of action is, that during sleep *less* oxygen is taken into the system; so that the waste is less, and the amount of venous blood is, at the same time, increased. Now, the element which combines with oxygen in the greatest quantity is carbon, and the presence of carbonic acid is the chief cause of the dark colour of venous blood. Scharling, Andral, Guvarret, Brunner, and others, have investigated the chemistry of respiration with the most brilliant success. I shall cite two of Scharling's results to illustrate the question before us. A soldier, twenty-eight years

of age, weighing 164 pounds, consumed of carbon per hour—

While fasting . . .	111	grains.
After breakfast . . .	159	,,
After dinner . . .	188	,,
Three hours after dinner	191	,,
Whilst asleep . . .	137	,,
Again whilst asleep .	122	,,

A young girl, weighing 46 pounds—

After breakfast . .	95	grains.
After dinner . . .	103	,,
After tea	99	,,
Whilst asleep . . .	75	,,
Again whilst asleep .	65	,,

As the horizontal position induces a feeble action of the heart and lungs, so there are other causes which tend to the same effect. Why is there a tendency to sleep after dinner? Macnish says that the drafting away of a large amount of nervous power from the brain, to effect digestion in the stomach, is the cause of this. But this position is merely assumed. What is meant by nervous power? The expression gives us nothing tangible for examination. It certainly involves the necessity for considering digestion as a vital operation in the highest sense of the word. But modern chemists regard digestion as a merely chemical operation. Indeed, this supposition that the mind yields a portion of its power to assist in digestion is purely hypothetical; and modern organic chemistry has opened a new world of wonders, and has let in a flood of light upon the subject. Mark, the tendency to sleep mostly follows an excess of food. The first effect of an excess of food is distension of the stomach. The cardiac portion of the stomach lies up against the great muscular partition called the diaphragm. The diaphragm is, by the distended stomach, forced up against the heart and lungs, and the free play of the latter is thereby impeded; so that we have in this case a condition parallel with that observed before, as a consequence of a recumbent posture, namely, a reduction in the rapidity of the circulation and respiration. Again, when the stomach is supplied with food, its villi enlarge, and its arteries become turgid with blood by the stimulation consequent on the presence of aliment. And, if a great accumulation of blood takes place at one part of the body, it must be at the expense of every other, and in this case we have not only a slower circulation and a feebler action of the lungs, but the brain is deprived of a considerable amount of arterial blood by the increased flow to the stomach. This explains the easy indolence of an obese idiosyncrasy, and that drowsy evenness of temper so frequently to be observed in those who are in the condition vulgarly termed "fat." In these, the adipose tissue accumulates, and permanently forces up the diaphragm; it also lodges around the edges of the heart and lungs, and these becoming restricted in their action from insufficiency of space, are at last permanently contracted. Have you not observed the antipathy of such persons to active exertion? It is a settled fact that everything which tends to lessen the respiration is a cause of sleep. The same may be observed in animals fatted for the butcher, the obesity of a prize cattle show illustrates the same fact. The stomachs of the animals are distended with food, the action of the heart is impeded by pressure, the lungs are choked up with fat, and the victims, after gasping ineffectually for active respiration, fall into a deep sleep.

And why so? What connection can subsist between the rate of the circulation and the amount of venous blood, and that quiescent state to which we apply the term sleep? We must invoke the genius of chemistry for a solution of this difficulty, for every physiological condition has its analogue in chemical law; but it suffices that we have explained physiologically why we lie down to sleep. KARL PROSPER.

METEOROLOGY OF JUNE.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

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Year.	Mean Temperature of the Air. Degrees.	Mean Temperature of the Dew Point. Degrees.	Mean Pressure of the Air. Inches.	Mean Amount of Cloud. (0—10).	Number of Rainy Days.
1846	67·7	53·1	29·876	4·5	10
1847	62·1	54·5	29·552	6·0	17
1848	59·3	51·8	29·626	7·6	25
1849	55·5	53·2	29·895	5·6	10
1850	60·0	53·6	29·873	6·3	10
1851	56·7	50·3	29·859	5·7	17
1852	57·0	50·5	29·536	8·0	25
1853	58·3	52·6	29·721	7·8	20
1854	55·2	48·9	29·713	8·4	14
1855	56·2	47·6	29·830	7·1	13
1856	56·2	49·2	29·842	7·0	13
1857	60·9	52·0	29·978	6·5	12
1858	64·4	51·6	29·917	5·7	8
1859	58·8	52·0	29·773	7·8	11
1860	55·6	49·1	29·608	8·9	25
Mean	58·9	51·3	29·773	6·9	15½

The mean temperature of the air for the last fifteen years, for June, is 58·9°, the range in the mean temperature being from 55·2° in 1854 to 67·7° in 1846—a difference of 12·5°. The lowest means occurred in 1849, 1851, 1852, 1854, 1855, 1856, and 1860, and the highest in 1846, 1847, 1850, 1857, and 1858.

The mean temperature for June, for the last fifty years, is 58·7°, and it was as high as 67·7° in 1846, and as low as 53·8° in 1821.

The mean temperature of the dew-point for June, of the last fifteen years, is 51·3°, the range being from 47·6° in 1855 to 54·5° in 1847—a difference of 6·9°. The mean difference between the temperature of the air and that of the dew-point being 7·6°.

The mean pressure of the last fifteen years, for June, is 29·773 inches at the height of 174 feet above the mean sea-level, ranging between 29·536 inches in 1852, and 29·978 inches in 1857—a difference of 0·442 of an inch (or less than half an inch). To reduce these readings to the mean sea-level, it is requisite to add 0·184 of an inch, when the mean temperature is as low as 55·2°, as in 1854; and 0·181 of an inch when it is as high as 67·7°, as in 1846. On applying this correction, the mean pressure of the last fifteen years, when reduced to the mean sea-level, is for June 29·956 inches.

The mean amount of cloud, for June, of the last fifteen years is 6·9 (or under seven-tenths of the whole sky); the amount being as much as 8·9 in 1860, and as little as 4·5 in 1846 (or only half as much). The years of much cloud were 1848, 1852, 1853, 1854, 1859, and 1860, and of but little cloud, 1846, 1847, 1849, 1851, and 1858.

The mean number of rainy days, for June, of the last fifteen years is 15½, ranging between 8 in 1858, and 25 in 1848, 1852, and 1860—a difference of 17 days. The years of but little rain are 1846, 1849, 1850, 1857, and 1858; and of much rain 1848, 1852, 1853, and 1860.

E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR JUNE, 1861.

—o—

The Sun is in Gemini until the 21st, and then in Cancer. He rises in London on the 1st at 3h. 51m., on the 10th at 3h. 45m., on the 20th at 3h. 44m., and on the 30th at 3h. 48m.; setting on the 1st at 8h. 5m., on the 10th at 8h. 13m., on the 20th at 8h. 18m., and on the 30th at 8h. 18m. He is above the horizon in London on the 1st, 16h. 14m., on the 21st, 16h. 34m., and on the 30th, 16h. 32m.

He rises in Edinburgh on the 6th at 3h. 19m., and on the 25th at 3h. 18m.; setting in Edinburgh on the 7th at 8h. 37m.; and on the 30th at 8h. 45m.

He rises at Dublin on the 3rd at 3h. 40m., and on the 22nd at 3h. 34m.; setting at Dublin on the 4th at 8h. 19m., and on the 23rd at 8h. 30m.

The Sun is on the meridian on the 1st at 12h. 2m. 40s.; on the 14th at 12h. 0m. 5s., and on the 30th at 11h. 56m. 43s.

The equation of time is on the 1st, 2m. 30s. subtractive, on the 14th, 5s. subtractive, and on the 30th, 3m. 17s. addative.

The Moon is new on the 8th at 1h. 38m. p.m.

Full Moon on the 22nd at 2h. 23m. p.m.

She is at her greatest distance from the earth on the 3rd, and nearest on the 19th.

Mercury is an evening star, and favourably situated for observation about the middle of the month; he is in Taurus at the beginning, then passes into Gemini, and is in Cancer at the end of the month, being at his greatest elongation on the 25th. Rising on the 5th at 4h. 36m. a.m., and on the 30th at 6h. 5m. a.m.; setting on the 5th at 9h. 40m. p.m., on the 15th at 10h. 0m. p.m., and on the 30th at 9h. 29m. p.m.

Venus is in Taurus at the beginning, and in Gemini at the end of the month, unfavourably situated for observation. Rising on the 5th at 4h. 0m. a.m., and on the 25th at 4h. 40m. a.m.; setting on the 5th at 8h. 45m. p.m., and on the 25th at 9h. 12m. p.m.

Mars is in Gemini at the beginning, and in Cancer at the end of the month, badly situated for observation. He rises on the 5th at 5h. 32m. a.m., and on the 25th at 5h. 21m. a.m.; setting on the 5th at 10h. 16m. p.m., and on the 25th at 9h. 39m. p.m.

Jupiter is in Leo, and a conspicuous object. He rises on the 5th at 9h. 13m. a.m., and on the 25th at 8h. 13m. a.m.; setting on the 5th at 12h. 0m. a.m., and on the 25th at 10h. 51m. p.m.

Saturn is in Leo, and, therefore, an evening star. Rising on the 5th at 10h. 23m. a.m., and on the 25th at 9h. 13m. a.m.; setting on the 5th at 12h. 37m. a.m., and on the 25th at 11h. 17m. p.m.

Uranus is in Taurus, and, being in conjunction with the Sun, is invisible.

Eclipses of Jupiter's Satellites:—On the 5th, at 11h. 11m. p.m., 3rd moon reappears. On the 5th, at 11h. 28m. p.m., 1st moon reappears. On the 20th, at 8h. 24m. p.m., 4th moon disappears. On the 21st, at 9h. 46m. p.m., 1st moon reappears. On the 27th, at 9h. 40m. p.m., 2nd moon reappears.

Occultation of Stars by the Moon:—On the 11th, ξ Cancri (5½ magnitude) disappears at 8h. 43m. p.m., and reappears at 9h. 46m. p.m. On the 17th, 69 Virginis (5½ magnitude) disappears at 11h. 49m. p.m., and reappears at 12h. 35m. a.m. On the 20th σ Scorpii (3½ magnitude) disappears at 6h. 50m. p.m., and reappears at 7h. 56m. p.m.

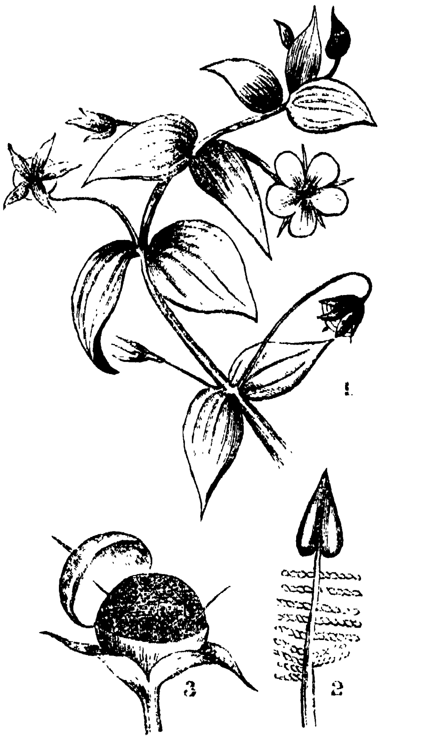
Stars on the Meridian:—On the 3rd, Arcturus souths at 9h. 20m. 9s. p.m. On the 5th, Antares souths at 11h. 23m. 30s. p.m. On the 5th, α Ophiuchi souths at 12h. 34m. 50s. p.m. On the 6th, ε Bootis souths at 9h. 37m. 52s. p.m. On the 8th, α Libræ souths at 9h. 34m. 17s. p.m. On the 10th, α Coronæ Borealis souths at 10h. 11m. 53s. p.m. On the 13th, α Serpentis souths at 10h. 8m. 42s. p.m. On the 19th, α Herculis souths at 11h. 15m. 45s. p.m. On the 27th, Arcturus souths at 7h. 45m. 47s. p.m. On the 30th, Antares souths at 9h. 45m. 13s. p.m. On the 30th, α Ophiuchi souths at 10h. 52m. 37s. p.m.

E. J. Lowe.

THE MICROSCOPIC OBSERVER JUNE.

A Study of the Anagallis.—When we begin to use the microscope, there are many small difficulties which our books do not notice or explain away. The great minds who wrote them have forgotten the day when the first microscope was puzzled over; the lenses screwed on inquiringly, "the live-box" examined curiously, the "spotted lens" a mystery not cleared up, and even the condenser awkwardly managed. As beginners are always coming to sources of information, this subject is selected for an elementary lesson. Use the *lowest* power of the microscope always, and only screw on a more powerful lens when it is absolutely necessary. A two-inch object-glass is the best for a general examination of a flower. On the table have a glass of water; some glass slides and bits of thin glass; four slides, with a square of white, black, red, and blue paper fastened underneath, giving various coloured grounds for the examination of opaque objects; a lancet, which cuts delicate slices or sections; a camel-hair pencil; several fine needles, mounted on small handles (ours are made out of lucifer matches). Nothing more is required for the examination of flower or insect by a young botanist or naturalist. Thus provided, we begin our work. This month of June is so rich in beautiful flowers and innumerable insects, that the difficulty lies in selecting our object for examination; but let us take that bright little wayside friend, "the poor man's weather-glass."

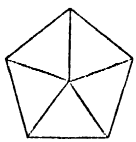
Anagallis (the Scarlet Pimpernel).—The very name tells of its brightness, Anagallis, from the Greek word, *Anagaleo*, to laugh. This merry little flower loves the sunshine and fair weather only, shrinking from the dark cloud and from the rainy day, closing its petals hastily before a storm to preserve its delicate organs from the slightest moisture. Neither does this weather-wise little creature awake very early, never before eight, a.m., and closes its pretty corolla again at about three minutes past two, p.m. For this reason it always makes one of the floral clocks, which marks each hour of the day by the opening and closing of a flower. In the scientific



1. *Anagallis pratensis.* 2. *Stamen with jointed hairs.* 3. *The seed vessel.*

world Anagallis has been classed thus:—Linnean class and order, *Pentandria monogynia*; Natural order, *Primulaceæ*, which means that it is first cousin to the pretty primrose, the polyanthus, the auricula, the cyclamen, to the tiny chaff-weed, and the sea-side glaux, or sea milkwort, beside other foreign grand relations, and many more country cousins. Moreover, it is an example of the pentagon flowers. In the wide, wide field of creation so great is the profusion, so infinite the variety, of vegetable life, that a young botanist scarcely realizes the order, and the evident adherence to a fore-arranged, fixed plan, which marks all the works of God. Even as the

astronomer, turning his telescope to the unfathomed space above, finds the most perfect order and laws immutable amidst those rolling spheres, so the naturalist with his microscope pauses at times, overwhelmed with the evidences of careful design and minutest attention to the order, form, and beauty of the object he examines. The architecture of a plant is a wonderful study; we shall consider that particularly hereafter. The present little flower is an illustration of a very graceful mathematical figure, the pentagon; one which we have seized upon for our human creations of beauty in the tracery of our church windows, and which we find in the garden and the field, combining regularity of form with beauty of colouring. Here is a pentagon, five equal sides, five angles or corners all exactly equal, and all the same distance from the centre. Now observe our little Anagallis. Five gathered into one, or one divided into five, that is the plan upon which it is



fashioned, *a plan* remember, and not by chance or at random, not carelessly, as the great power of God might seem to make all things in the good pleasure of his will. First the calyx, all in one, with five deep points. The corolla, also all in one (monopetalous), fitting by a short tube into the calyx, and spreading into five divisions, or lobes. Five stamens, each exactly opposite one lobe of the corolla—a fixed rule in this tribe, and not a common one, for usually the stamens are alternate with the lobes, as you may see in the borage and its brethren. One pistil or *staub-weh*, as the Germans call it, an excellent name, meaning "pollen-path," which it is; the loosened tissue forming innumerable little channels or paths, whereby the pollen grains cast down their tiny tubes, and reach the ovary to perfect the seed. The stamens are called *staub-fäden*, pollen-thread, the filament supporting the various-shaped anther full of the fructifying "dust." Let us examine the flower now more closely. With the lowest power on the microscope take one of the coloured segments of the corolla, and press it lightly in a drop of water under a bit of thin glass; we shall see that the edge of the petal is fringed with little bell-like glands, purple and white, and that hues of deeper colour radiate from the base of the petal. Now let us look at a stamen on another slide in the same way; half-way up the slender white stem are purple-jointed hairs, like a row of fairy amethysts; above is the heart-shaped anther, with its golden store of pollen-grains, out of each of which will flow the life-giving germ to the future seed. Take the style, and upon the stigma you will see a viscid juice exuding which has fixed the pollen-grains, and steadied them as their tubes descended the *staub-weh* to the ovary beneath. As the Anagallis flowers gradually from the root upward, you will probably find a seed-vessel half ripe upon the stem. It is very beautiful and peculiar, opening like the lid of a box, and within are the most exquisite seeds, arranged on a central column; they are of a delicate green colour, and as if frosted with silver, dotted all over, a sight not easily forgotten. This form of capsule is called a pyxis; no other flower except the henbane has exactly the same. If we now put on a higher power, and return to the first slide of the petal, we shall see that the little purple bells are jointed at the base, as if they could ring out a merry peal to the winged creatures who flit near, and draw them to banquet on this golden store and sweet nectar. The dark lines we saw radiating from the base of the petal, if we now press the glass tightly, are manifestly spiral vessels, not one only, but many in a line, short, and joined to each other by a delicate dovetailing process; which vessels conduct air through the petal, and probably give it elasticity and power of contraction. Think of the mechanism in that one small flower; the hidden uses, the marvellous beauty we have so often passed carelessly by, and think of the Almighty hand which fashioned it so daintily, taking pleasure Himself in the arrangement of all its parts. "For thy *pleasure* they are and were created," is true of the simplest flower as of the brightest star that shines in the immensity of space. The limits of my corner will not allow me to give another flower at full length stretch, but let me direct the young botanist to the little garden chickweed (*Stellaria media*). Take one of its *smallest* open flowers, and place it on the red slide, throw light upon it with the condenser, and the beauty of this little weed will delight you. The sepals so brightly green set off by the crimson ground of the slide, will show themselves fringed by jointed, glandular hairs. The snow-white petals seem fretted with silver meshes, the kidney-shaped stamens of a rich crimson hue are reticulated, and those which are unfolded display upon a dark blue or violet lining the golden balls in clusters, pollen grains, themselves a study for a higher power; then the lovely three-plumed stigma, seemingly crystallized, and on the fretwork pollen grains arrested, and fructifying the ovules below. Make a section of the ovary across the bottom of the style, and the ovules are seen like little eggs in a pretty green nest, which ovules grow into dotted seeds well worth seeing when ripe. Let me urge every one who studies Natural History to keep a note-book, and those who *can* draw to do so at the microscope. The observation of minute beauties will stamp them on the memory, strengthen its power and quicken the eye also to perceive what hundreds never see. Make notes of the shapes of stamens. The position and opening of the anthers, the shape of the pistil and its stigmas. Examine the ovary, and mark how the seeds are placed within. If there are more cells than one, cut several ovaries to see the ovules in all their stages, then examine every ripe seed, its shape and its markings. Do this as if no one had ever done it before, and the exercise will be worth years of mere book-learning.—L. LANE CLARK.

CLUB MOSSES.—The pretty plants of the order *Lycopodiaceæ* are receiving a considerable share of attention now by horticulturists, as the culture of all the species is found to be very easy, and in accordance with the growing taste for elegancies of form, irrespective of gaudy colours. The possessor of a

few glass shades may soon have them filled with the creeping club-mosses of the *Selaginella* tribe by providing sweet sandy peat, and inserting in it small pieces of selected plants, with ready-formed roots at the bifurcations of the stems. There is nothing in the classes of ferns and mosses to surpass the beauty of these curious *Cryptogams*. The majestic feathery character of *S. mertensii*, the metallic blue of *S. cæsium*, the well-known lively verdure of *S. denticulatum*, and the various hues of *S. Africanus*, *Lævigatus*, etc., are severally distinct and unique, and give to the microscopic study of the plants all the charms of elegance and taste. We have lately seen the common British club-mosses in an admirable state of culture in the fern-house of — Mongriedien, Esq., at Forest Hill, where *Lycopodium inundatum* is used to clothe the sides of fern baskets suspended over a tank. The first object that will strike the attention of the microscopist is the pellucid aerial rootlets that issue from the joints along the stems, and which in the moist air of a close bell-glass absorb nourishment as freely as if immersed in the soil. This is the method of reproduction to which the cultivator ordinarily resorts, because the surest and the quickest; but the microscopist will prefer, if possible, to raise plants from spores, and this will lead to a study of the modes of fructification. The spores occur in dehiscent cases at the base of the leaves, and may be traced by means of a Coddington applied to the upper surface. In some cases there is a departure resembling that of *Osmunda* among ferns, the fertile leaves being collected in spikes, so as to give a more distinctly flowering character to the species. *Lycopodium complanatum* is an example of this; the spores rise in imbricated pyramidal clusters above the general outline of the fronds; and *Lycopodium lucidulum*, which throws up spikes resembling the fruit spike of an *Equiseta*, but with a spinous process at each imbrication. The spores of *Selaginella* are of two kinds: the one kind known as oospores, the other pollen spores, distinguishable by the former being larger than the latter, and produced on the lowest scales of the lateral leaf-spikes. If a few stems of *Selaginella mertensii* are allowed to perish and become dry, they will be found, on attempting to break them, to be furnished with a tough fibre, running the whole length along the centre of the stem. This cord is the origin of the fibro-vascular bundles which ramify from the stem to the leaves, and give an arborescent character and considerable rigidity to the plant. We have grown this species to a height of twenty inches, perfectly erect and self-supporting, and its appearance then was singularly graceful, the summit curving over in the orthodox fashion of a Prince of Wales's feather. The fibro-vascular bundles consist of spiral ducts, which, by secondary deposits, acquire a ligneous character. The reproduction is pretty well understood in the case of *Selaginella*. The two kinds of spores behave very differently when sown. The small pollen spores discharge minute cellules, "in each of which is developed an actively moving spiral filament, which breaks out and swims about rapidly in the water when seen under the microscope." The oospores remain apparently dormant for a length of time, during which cell formation proceeds within them, the results of which are very minutely described at page 439 of the "Micrographic Dictionary." There are two families of *Lycopodiaceæ*: 1. *Locopodieæ*, in which there are two genera—*a*, *Lycopodium*, the sporanges of which are of one kind, and *b*, *Selaginella*, the spores of which are of two kinds: the small spores (pollen-spores) resembling those of *Lycopodium;* the other and larger spores (oospores), situated at the base of the spikes, four-lobed, and containing four spores. The collection of the British Lycopods and exotic *Selaginellas* is as interesting a pursuit as any within the range of microscopical studies, and will well repay by the various elegancies the plants exhibit under a proper system of cultivation.

Mr. Noteworthy's Corner.

Deep Sea Life and Submarine Cables.—The popular opinion was pretty freely expressed, on the occasion of the deposit of the Atlantic Telegraph, that some sea monster, whale, shark, sea-serpent, or dragon, would, in a mischievous freak, chump it up and digest a mile or two for mere amusement, but sea-serpents and dragons of the deep have been treated with profound contempt by marine telegraphists. There is always a grain of truth perceptible among the dregs of popular folly, and the little *pholades* that make ships into colanders by their reticulated borings, and the cephalobranchiate *annelids* that make cables of their own by the agglutination of foraminiferous shells, are not to be so quietly ignored in any case where large sums of money are invested in scientific appliances that are entrusted to the fury of the sea. Marine animals mostly affect the zones of least depth, and, consequently, there is a greater abundance of life in the vicinity of sea-coasts than far away in the deepest waters. Whatever danger, therefore, may arise through the attacks of marine animals on the sheathing of telegraphic wires; it diminishes with the relative depth to which they are submerged, and *vice versâ;* but at the greatest depth ever sounded, life is, nevertheless, possible. As to the facts of the case, Sir John Ross, in his "Voyage of Discovery to the Arctic Regions," published in 1819, recorded the occurrence by soundings of annelids (sea-worms) at depths varying from 192 to 1000 fathoms. Samples of sea-bottom, consisting mainly of stones and mud, brought up from a depth of 1000 fathoms, exhibited annelids as the normal inhabitants of the mud, not as the accidental result of drifting currents or tidal influences. In one case the line brought up, from a depth of 800 fathoms, a specimen of *Gorgonocephalus arcticus*, measuring two feet in length, which is now in the British Museum. Starfishes, mollusks, and crustaceans were also procured from a similar depth in Baffin's Bay, and we may fairly infer that on a warmer sea-bottom than that

operated upon by the great Arctic voyager, a more various fauna would be discovered. We turn to the recent survey for the Atlantic Telegraph, conducted on board H.M.S. Bulldog, and our preformed notions of the confined areas of marine life are at once upset, for pelagic life is evidently liberally diffused. At 1260 fathoms, midway between Greenland and the north-west coast of Iceland, *Ophiocomæ* were found in abundance. These are star-fishes of the order *Asteroidea*, with long rays distinct in outline from the central disk. Dr. Wallich has sufficiently explained the plan on which the soundings were made, to remove all possibility of doubt as to their being derived from the sea bottom, and not from any point intermediate between the surface and the bottom, as might be inferred from a mere statement of their occurrence on the sounding line. On dissecting these *Ophiocomæ*, their stomachs were found to be liberally filled with *Globigerinæ*, and we are thus led a step further to the conclusion that *Foraminifera* abound with them as active agents in the formation of marine deposits. Dr. Wallich says the deposit brought up consisted of 95 per cent. of these same *Foraminifera*, the presence of which constitutes the region a feeding-ground for star-fishes. But more important still is it to note further that specimens occurred of tubes formed by shells of *Globigerina*. These tubes were about a line in diameter, varying in length from one-sixteenth to one-fourth of an inch, and so constructed as to lead to the inference that at 1913 fathoms minute annelids are as abundant as members of the same family are in the shallow waters upon our sandy shores. The question arises, is it of any consequence to the promoters of ocean telegraphy that such organisms have been met with as veritable occupants of deep sea bottoms? *A priori*, it must be worth while to know what sort of companionship a cable is to have when committed to the ooze and tangle, after an expenditure in its production of thousands of pounds. But *à posteriori*, the Mediterranean cable suffered from borings made by *pholades* at a depth of 60 to 70 fathoms; that is to say, the cable, as well as its inclosure of gutta-percha, was pierced by *Xylophaga dorsalis*, a well-known destroyer of submerged timber, and first cousin to *Teredo navalis*, the dreaded ship-worm. Mr. Jeffreys adduces instances of drift wood pierced by conchiferous mollusks, but a *floating* object offers no illustration of the circumstances of a submerged cable. It is something towards the attainment of an object to know all the difficulties with which it is beset, and clearly enough submerged cables have to contend for empire with echinoderms, mollusks, annelids, crustaceans, foraminifera, and some possible rhizopods, or whatever may be the originators of those "coccoliths" of Professor Huxley. The thought that occurs to us as to the practical lesson of these facts is, that to prepare cables in any way to repel such creatures—and we have in view the *pholades* only at present, as to be feared—will be found much more difficult than boldly inviting them to make their attacks, and from their united efforts deducing for the cable an element of strength instead of weakness. We will suppose a cable to lie on a sea-bed, fully exposed to the attacks of *pholades*, and the date of its disability is not far off. But suppose it so prepared with a rough exterior, in which crustaceous or siliceous matters predominate, that the tendency of tube-forming annelids and deposit-building foraminifera to coat and cover it with a calcareous crust is greater than that of the toredos to pierce it, and thenceforth the proper inhabitants of the bed of the ocean become agents in its preservation; it is in time invested with incrustations that shield it from the attacks of borers, that possibly arrest the progress of decay in the vegetable coating, and that increase the insulation to an extent appreciable in the electrical fidelity of the transmitted currents. A few easily-performed and costless experiments would determine whether it is possible to prepare cables in a way to facilitate their incrustation, and if so, what practical benefit is to be looked for as the result of the process.

The Finding Microscope.—Microscopists seem, so far as we are aware at least, to have lost sight of the primitive or telescopic form of the compound microscope, a form which, if properly constructed, would, in the hands of the naturalist, prove a most useful and interesting instrument to facilitate the finding of the smaller plants and animals, the examination of comparatively near but unapproachable objects, looking at pictures, etc. We have had the object-glass removed from an ordinary pocket telescope, and an object-glass of a shorter focal length fitted in its stead, so that the focus of the new objective is less than one-half the length of the instrument. Thus, coupled with the advantage of objects appearing erect in position by the use of the erecting eye-piece of the telescope, we have also procured double the extent of draw or focussing range that any ordinary telescope will be found to have with an object-glass of the same focal length. By this arrangement the instrument will be found to come to a perfect focus with a pretty large sharp field on objects at any distance that exceeds the focus of the object-glass. By this simple alteration any pocket telescope may readily be transformed into a finding microscope. We suppose, however, that this instrument, properly constructed, with lenses specially corrected to focus on objects at a medium distance, say four feet or so, might be produced by some of our opticians with a power and definition approaching to such perfection that its application would open up, as it were, the every-day life in the wood and meadow, pond and streamlet, enhancing everywhere the wanderings of the student of Nature, and becoming an auxiliary of no mean importance to his studies. It is also calculated to save the time of the naturalist in a great measure, by enabling him to scan, while walking and erect, with microscopic power and penetration, a considerable extent of country, or examine minutely the length, breadth, and depth of ponds in a short time. It tends, also, to remove many of the annoyances and dangers that impede the progress of the excursionist. Besides, the interest that attaches to its revelations of insect life

and activity only require to be shown to make the instrument a favourite. Thus far have we found the finding microscope useful and very interesting, and doubt not that, if it were applied in this way, it would turn out a most important acquisition to the naturalist, and a useful accession to his collection of instruments, as by its aid observations may be made on plants and animals in their natural elements, and many facts collected that cannot possibly be without some such instrument. When it is applied to pictures, photographs, or prints, it is also gives a stereoscopic beauty and relief. It is by no means useless as a telescope; with that we have in use the spots on the sun are seen pretty distinctly, and Jupiter's satellites on very favourable nights.—J. R. LYLE.

A NEW ELECTRO-MOTIVE ENGINE.—The attractive force of an electro-magnet being greatest at the poles, necessitates the closest proximity between *it* and the moving parts in all magnetic machines, and this constitutes the chief difficulty in their construction. Now this difficulty can be entirely removed by making use of its *repulsive* force only, as I shall endeavour to show. Let there be three electro-magnets, as seen below, each in connection with a galvanic battery:—

N———S N———S N———S
1 2 3

The outer ones so placed as to allow the centre one to move freely between them, and let this centre magnet be connected with a "Golding Bird" inversor, or any other contrivance for reversing the poles. Now, imagine the pole of No. 2 to be in contact with No. 1, and no sooner is it in contact than it is repelled to No. 3; and no sooner is it in *contact* with No. 3 than, by means of the inversor, the poles are reversed, and it is again repelled to No. 1, when the same action takes place as at first. Such is the *principle* which I have in view in the construction of a machine which, from want of means, I am at present unable to make a model of. I therefore leave it for the consideration of your readers. It will be seen that, by the method I propose, the *whole* amount of power of an electro-magnet is obtained, which is not the case in any of the machines now in use, most of them acting by a rotatory motion, and not by a rectilinear and reciprocating one as in this.—N. ABERDARE.

LAPWINGS, WORMS, AND BLACKBIRDS.—Mr. Selby describes the way in which lapwings obtain worms, viz., by stamping on the ground with their feet, and seizing the worm when it makes its appearance, which it soon does, probably through fear, thinking the noise caused by some of its subterranean enemies. I have never seen the lapwing do this, but I have repeatedly observed blackbirds procure food in a similar manner. After a slight shower I have noticed them come on the lawn, and hop about in search of a worm-hole, and when they have found one they will beat the ground *with the beak*, and then watch, with the head held on one side, like that of "a magpie peeping into a marrow bone." If the worm do not presently appear the process is repeated, and generally with success. Many of your readers, I have no doubt, will have noticed, in districts frequented by blackbirds, stones surrounded by fragments of snails' shells; this also is the work of blackbirds. They are exceedingly fond of snails, and are in the habit of carrying them to a stone, and dashing them upon it until the shell is crushed sufficiently to enable them to extract the unfortunate mollusk—a most effectual mode of making him "shell out" certainly. As for the hedgehog sucking the milk from cows, etc., I think if any one will take the trouble of examining the mouth of one, he will be convinced of its impossibility.—LINDOM, *Brigg*, 13*th May*, 1861.

THE AURORA OF THE 9TH OF MARCH.—Thinking it might interest some of the readers of RECREATIVE SCIENCE, I send an extract from a meteorological review of third month, 1861, in the *Picton* (Canada West) *Times*, describing (most likely) the same Aurora as seen in this country on the 9th of March. Picton is situated about 44° north and 77° west of Greenwich, which, of course, would make some difference in the time:—The 9th was rainy in the morning. Mercury rose to 30° at 1 p.m., clear after 4 p.m. A very fine Aurora in the evening. The coruscations were very vivid, and shot up from the horizon north of the Prime Vertical, 12° or 13° south of our zenith, while the auroral light was reflected as far south as Rigel, in the foot of the constellation Orion, or 8° south of the equinoctial. At first the rays did not meet in a focus, but terminated in the arc of a circle of 12° or 15° in diameter around the stars Castor and Pollux. In a short time, however, this arc disappeared, and the "merry streamers" met in a common focus.—JOSEPH CLARK, JUN.

STAINING GLASS RED.—"X Y Z" is advised to follow these directions:—Wash the glass with gum-water. Prepare the stain by mixing (also with gum-water) rust of iron, glass of antimony, litharge, each in equal quantity; a little sulphide of silver should be added. Lay it on the glass evenly, and then dry. Raise to a red heat, and when cold rub off superfluous colouring matter; that is, all that has not entered the pores of the glass.

MEMORANDA.—Silver is likely to be largely produced in the Cornish mines. In January last the Rosewarne and Herland mines yielded an ore which sold at from £27 to £77 per ton.——Gratiolet and Cloez pronounce the acrid fluid of the toad to be a powerful poison. Dr. John Davy tried it upon a kitten, a fowl, and a slug, none of which suffered in the least. A story was circulated last summer that a Hungarian peasant had died from the effects of toad poison. It appears, however, that the toad is as harmless as enlightened naturalists have asserted it to be.——The triple lenses of M. Dallmeyer have been extensively and severely tested by photographers this spring, and the general opinion is, that it is the best adaptation yet devised for the prevention of distortion.——Further experiments with the Wourali poison confirms its value as an antidote to strychnine. We owe a knowledge of the wourali to Waterton, the naturalist.

THE GORILLA.

Is the Gorilla a myth? Is M. Du Chaillu a weather-worn traveller, or the author of a hoax? These are questions asked under various shades of doubt and scepticism, and answered in diverse forms of faith, misgiving, and denial, or deferred reply in cautious reticence. The gorilla is certainly an established member of the quadrumana, brought into prominent notice by the new traveller's tales; and amid the sharp discussion as to his veracity, and his assumed claims as an explorer and discoverer, we feel it our duty to tender him our thanks for giving new interest to an old subject, by adding to it much that is new *and* true. We can hardly say that the pleasure afforded us by the perusal of Du Chaillu's fascinating narrative has been wholly balanced by disappointment. For though our anticipations of additions to our stock of knowledge of the mysterious region of equatorial Africa have not been realized, yet in the perusal of his attractive volume we have been enabled, in some measure, to tread the wilds with him, and form more accurate estimates of the phenomena of Nature in the regions comprised in the descriptions of his travels.* It is a real service for science to cause inquiry and discussion. M. Du Chaillu has certainly accomplished so much, and through him the world is indebted for the reassertion of opinions on weighty matters not purely physical in their import, by the master-minds of modern science. To make the best of the adventurous and inventive American, then, we are indebted to him for recalling attention to a portion of the world about which we know but little, but had need know more for the sake of science and civilization. It is not surprising that this work should have created a great sensation, for apart altogether from the one subject on which discussion has chiefly arisen, the narratives of missionary work, native customs, distribution of tribes, sporting adventures, and personal mishaps, are told with an artlessness that has a hundredfold the charm of any so-called "fine writing," for, in plain truth, the diction is somewhat on the plan of Defoe, and works a spell upon the reader by simple detail and minuteness of fact, rather than by skilled metaphors and rounded periods. But the author draws a long bow: of that the book contains internal evidence, and because of certain exaggerations, some have been bold enough to express doubts if he has really seen any portion of the regions he has thus elaborately described. But the internal evidences of genuineness are as strong (more so) as those of an opposite tendency, and the truth seems to be that the traveller was careless in the keeping of his journal, that the greater part of his work has been written from memory, and that invention has often come to his aid, where it would have been preferable to have left a visible hiatus and a broken record. So much for the book, which will attain to greater popularity yet than it at present enjoys; for, happily, the reader possessed of a moderate share of general knowledge, will be able to detect the lines of demarcation between fact and fancy in the perusal of its really wonderful and fascinating pages, and though we may not forgive the author for making too bold a demand upon our credulity, we shall still acknowledge our indebtedness for directing attention to a region of wonders, about which but little as yet is accurately known.

The Gorilla (*Troglodytes gorilla*) is the *pièce de résistance* set before us in this African feast of literary curiosities. It is the chief figure in the picture, the centre of interest and the bone of contention. We will deal

* "Explorations and Adventures in Equatorial Africa, with Accounts of the Manners and Customs of the People, and of the Chase of the Gorilla, Crocodile," etc., etc. By Paul Du Chaillu. John Murray.

with it, briefly, as a matter of fact. It is a huge anthropoid or man-like ape, rather plentifully distributed in the equatorial regions of the African continent. It is not new to science, though new to the public, through the specimens exhibited in M. Du Chaillu's collection, in the rooms of the Geographical Society, at Whitehall Place.

M. Du Chaillu has a paragraph (p. 343) on the voyage of Hanno in the sixth century before the Christian era, in which he suggests that the "wild men" met with by the Carthaginian voyager, were veritable gorillas, the skins of which were brought to Carthage, and described by Pliny as hung in the temple of Juno. This, however, may have been the chimpanzee, hitherto regarded as approaching nearer to man in its osseous structure and cerebral organization of any of the family of quadrumana. The first reliable account of it was given by T. E. Bowditch, in his "Mission to Ashantee," 1819. In 1846, the Rev. Dr. Wilson, a missionary at Gaboon, West Africa, obtained a skull of this ape. Shortly afterwards, the same person presented a skull and part of a skeleton to the Boston Natural History Society. Subsequently Dr. Savage and Professor Wyman, of Boston, gave the first memoir on part of the skeleton and the cranium. So far "there is nothing new under the sun." It must be added that there are specimens of the gorilla in the Museums of Paris, Brussels, Vienna, and Leyden, and also at the British Museum, where it may be found in its place in the Zoological Gallery, placed beside a complete human skeleton, for purposes of comparison.

The gorilla is an enormous ape, and attains a height, in full-grown males, of at least six feet five or six inches, the average height being apparently about five feet six inches. Dr. J. E. Gray cites a letter of a naturalist, who says the Vienna specimen is "almost a head taller than I am, and I am six feet odd." It is powerful in proportion to its size. The bony fabric is characterized by the bulkiness of its proportions, the shortness of the posterior limbs, the immense length of the anterior limbs, the great width of the pelvis, the forward projection of the jaws, and the low facial angle. It is the immense size of the creature that calls forth surprise, not any particularly close resemblance to man; for it is, in cranial capacity and all its homologies, in no respect more exalted above the beast, than any of its congeners in the section of anthropoid apes. At South Kensington Museum a photograph of the British Museum skeleton can be purchased for a few pence, and there can be no temptation and no necessity for a figure of it here. But as a certain section of quasi-scientific theorists have sought to derive from the comparison of the apes and man a new item of evidence in favour of the Lamarckian hypothesis, and, in fact, would fain persuade us that the gorilla is a relation by blood, we will offer a few remarks on the more important of the cranial distinctions that present themselves when man and gorilla are placed side by side.

"I must own that," says Du Chaillu, "at first sight, judging from the living specimen, and from its cranium, the gorilla presents all the features of a far more bestial animal than the chimpanzee or the orang.* All the features of the gorilla are exaggerated; the head is longer and narrower; the brain is backward; the cranial crests are of immense size; the jaws very prominent; the canines very large. The proper cavity of the brain is marked by the immense occipital ridges." In the diagram of the skull (front view) the large ridge over the eyes, and the crest on the top of the head, extending over upon the occiput, together with the corresponding developement of the temporal muscles, and the large canines, are the main outward characters which seem to remove

* We are not prepared to accept the *T. Calvus* and *T. Kooloo-Kamba* as species, till we can discover in them something new.—K. P.

the gorilla further from man than the chimpanzee, and give to this animal so ferocious a look. The crest, or the top of the head,

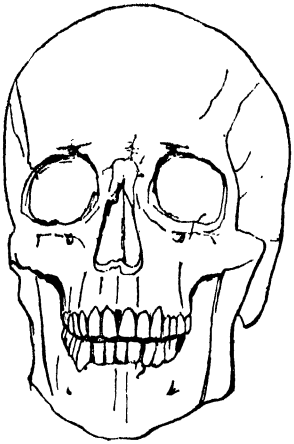


FIG. 1.—Caucasian Man.

becomes rounder as the animal grows older. It will be observed that in the region commonly assigned by phrenology to the

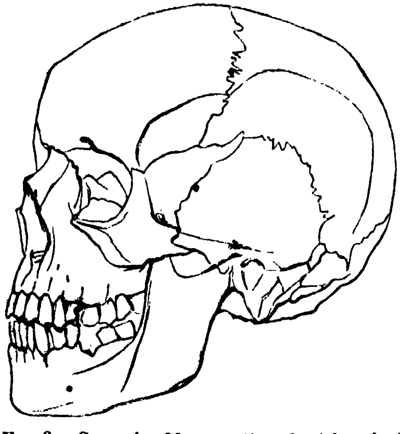


FIG. 3.—Caucasian Man, profile. Facial angle, 86.

intellectual faculties, the skull of the gorilla is so pinched and depressed that, for intellectual purposes, it may almost be said to have no brain at all. In this respect it is, in fact, inferior to the chimpanzee, which must keep its place as approaching nearer to

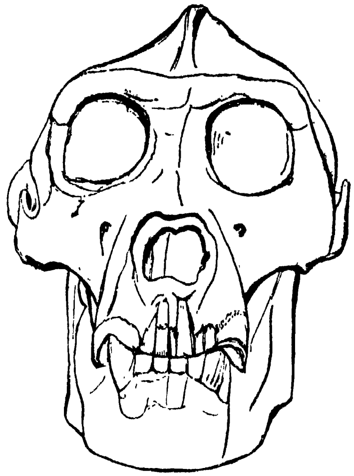


FIG. 2.—Male Gorilla.

man in cranial structure than any other of the anthropoid apes; so, in this department of the comparison, no new argument

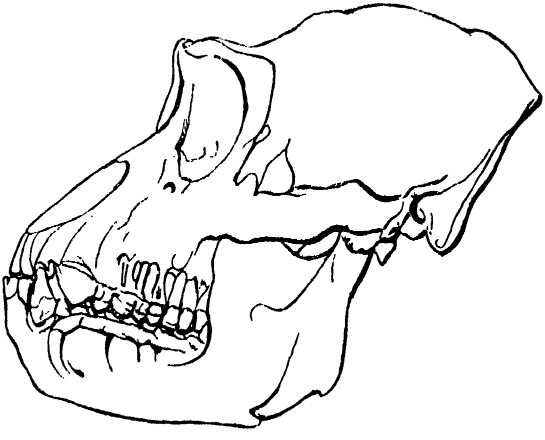


FIG. 4.—Male Gorilla, profile. Facial angle, 49.

can be founded in favour of transmutation. Now compare the profile, and the distinctions between man and gorilla are most

strikingly exhibited. The small brain of the ape is thrust backward, and the cerebellum preponderates. The projecting muzzle, the huge occipital ridges, and the prolongation of the occiput, mark the beast as eternally separated from man in any supposed order of physical progression. If the skull of the Negro or native Australian be used in the comparison instead of the Caucasian man, the difference is scarcely less striking, and still sufficient to show the impassable nature of the barrier to transmutational development, and to fix the permanency of species.

The brain of the gorilla fills the cranial cavity completely, and, therefore, the cranial cavity will be a true measure of the form and bulk of its cerebral contents. Professors Owen and Huxley are (as usual) at variance as to the correspondences and differences discernible in the comparison of the brain of this ape with the brain of man; but the careful observer will not be slow to discover that the question is rather one of terms, and the distinctions of bulk, form, and texture are quite sufficient to constitute a great gulf between them, irrespective altogether of the relative developments of the *Hippocampus major* and *minor*, the posterior horn and the lateral ventricle, and the indefinable posterior lobe of the cerebrum. In the gorilla the cerebellum is more largely developed than in the chimpanzee and orang, and in that respect, says Professor Owen, both the latter apes seem to approach nearer to man: "But the difference, as compared with the Negro, is so much greater than is that observable between any two steps in the descending series from the chimpanzee to the lemur; or, in other words, the rise in cerebral development is so great and sudden in the Negro, especially when the bulk of man's body is considered, that it seems to me to constitute one, and the most important, of the differential structural characters between the human and the ape kinds." In the gorilla, according to Professor Huxley, the greatest length of cerebral cavity is $4\frac{6}{10}$ inches. In the section of a human (Australian) skull, the greatest length is $6\frac{4}{10}$ inches. The projection of the cerebrum beyond the cerebellum (Professor Owen contends that it does not project at all) is, according to Huxley, $\frac{3}{10}$ths to $\frac{4}{10}$ths of an inch in the gorilla, and in the human (Australian) skull rather less than $\frac{3}{10}$ths of an inch. In the case of the gorilla the projection amounted to $\frac{1}{15}$th of the length of the cerebral hemispheres; in the human (Australian) the hemispheres projected $\frac{1}{20}$th of their length, "hence it follows that the backward projection of the posterior lobes beyond the cerebellum is not only relatively but absolutely greater in the gorilla than in some men." M. Du Chaillu says, on this

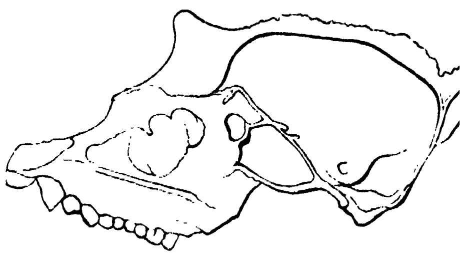


FIG. 5.—Section of Gorilla's Skull, one-fourth size of nature (Huxley).

point, "The corresponding small amount of brain in the male gorilla, and the excessive preponderance of the cerebellum or back brain, with its enormous strength, would seem to corroborate our opinion of the excessive brutality of this beast."

The cranial capacity of the gorilla is much smaller than appears by a section of the skull. The average of 10 males was 29·70; the average of 3 females 26. The maximum capacity was 34, the minimum 24. The average capacity of the adult Negro and Australian brain is 75 cubic inches; the lowest capacity, 65 and 63, was found among the Hottentots and Australians. The average of 13 adult gorillas was 28·85 cubic inches. "The difference in size of brain or cranial capacity," says Dr. S. G. Morton, "between

the highest ape and the lowest man is much greater than between the highest ape and the lowest ape. From 35 in the ape, the highest capacity observed, the capacity expands at once to 63 in the lowest human cranium.

The variation of size of brain is considerable in the human species, but the position and the quality of the brain have more to do with the intellectual manifestations. The average capacity in the adult Caucasian skull is 92 cubic inches, and the maximum is 114 inches; the average weight of a brain of a male Caucasian is 4 lbs. troy. It is also worthy of remark that in man the brain continues to increase in bulk until the adult age is attained, and after that it sometimes increases in weight. In the gorilla and the rest of the apes the actual increase of the brain is very slight; there is advancement to a certain point in the young animal, and the further growth is then suddenly checked, and the limit of intelligence is probably reached in the first year of its life.

Independent of relative measurements, as, for instance, the immense length of the fore-arms, the breadth of the pelvis, the contraction of the cervical vertebræ, and other obvious differences, there are the following distinctive characters, of an osteological kind, discernible when man and gorilla are placed side by side:—Man has 12 pair of ribs, the gorilla has 13. Man has 12 dorsal vertebræ, the gorilla has 13. Man has 5 lumbar vertebræ, the gorilla has but 3. Man has 5 sacral vertebræ, the gorilla has 6. Possessors of Mr. Fenton's photograph may count off these divisions of the spinal column, and understand thereby the proneness of the ape and the erect attitude of man. The figure in Du Chaillu's book, though not severely accurate, will exhibit the same distinctions and confirm our assertion, that the gorilla affords no aid to the advocates of transmutation, either by progressive development or natural selection.

The question will arise, what are the habits of a creature thus constituted? The author of "Explorations and Adventures" describes it as ferocious beyond parallel in the ape tribe; as not only defending itself with stubbornness when assailed, but as choosing the offensive without provocation, and challenging man to combat by an exhibition of savage rage of the most extravagant character. It advances in an upright attitude, uttering, as it approaches, a roar "which literally and closely resembles the roll of distant thunder along the sky," and its eyes flash with expressions of vengeance. More than this, its attack is deadly, for by one blow of its immense fore-arm it disembowels its human antagonist, and thus establishes its claim to be considered the king of the forest. None of our investigations of the skeleton lend support to this statement. Like the rest of the apes, it is evident that the erect attitude would be as difficult to this creature as to others which need a long course of training to enable them to assume it, even during a short period of time, unless sustained by the support of a staff. Furthermore, it is not carnivorous, and has no appetital incitements to attack either man or beast. But it is still more important to observe that the skin in the palm of the hand of the gorilla is as soft as silk, and that therefore it is next to impossible that it should perform such a war-dance and so systematic an attack, "beating its breast" the while, as M. Du Chaillu represents it. Clearly enough it is an enormous ape, powerful, and perhaps savage when provoked, but having as little place on *terra firma* as in the open sky, and possibly quite as well fitted to fly as to walk. Like the sloth, of which extraordinary tales had been told until Mr. Waterton studied its habits in its native wilds, so the gorilla has its home among the branches of trees, and is probably as harmless as any other of the anthropoid apes.

KARL PROSPER.

THE RISING AND THE SETTING OF THE SUN PHYSIOLOGICALLY CONSIDERED.

We all know that the sun and moon appear larger at their rising and setting. Various explanations have been offered, more or less satisfactory, according to the various complexions of mind in the student; but the best accredited of these have not found much popular favour, though they have had the advantage of being anything but dry and mathematical demonstrations. They are not demonstrations at all, indeed; rather a "common-sense argument," resorted to after all attempts at actual demonstration had failed.

Let us cursorily look at the facts. When Science first turned its attention to this subject, it very properly took into consideration, at starting, the known conditions of the luminary, under its two different appearances of larger and smaller:—larger on the horizon, smaller in the zenith. It asked, or rather stated, the difference between the horizon-condition, and the zenith-condition. The sun or moon on the horizon was seen through the greatest possible amount of vapours, or dense air; in the zenith, through the least possible amount of such density. It was natural, then, to seek the cause of the enlarged *horizontal* appearance in the fact of the increased *horizontal* density.

We may say enlarged *appearance*, since it was well known to every student of astronomy that the sun when it rose was certainly not any nearer to the observer than when it was shining at noon. It was certain that it did not subtend a larger angle when it *appeared* larger (rather the reverse), and that if measured it would be found to subtend (practically) the same angle in both cases. It was natural, then, to expect that the increased amount of density would involve the cause of the enlarged appearance: but here a difficulty was encountered at once. The increased density would increase the refraction; and the increased refraction would decrease the apparent magnitude, or angle of subtense. The mists on the horizon would, in fact, make the luminary look smaller instead of larger, and this in a strictly optical or mathematical point of view: it would make it smaller in a mirror or camera obscura. If, therefore, the phenomenon was attributable to mist, it was not owing to refraction consequent thereon, that was clear.

Then there were two different solutions offered, one of which, perhaps, has attained somewhat more favour with mathematicians and astronomers than the other, but both of which will be here noticed, since both most unquestionably account for some part of the phenomenon at least. In one of these the consideration of mist (having proved discouraging) was abandoned altogether; in the other it was still retained as a fundamental cause, though its concomitant refraction was discarded.

The first solution stated that since, when the sun is on the horizon, we see it contrasted with some object there, which is necessarily much diminished by distance, the size of the sun is exalted by the comparison—a doctrine supported by Sir J. Herschel, and many eminent astronomers of the present time. But though this argument proves most satisfactorily that the luminary would from this cause alone appear larger on the horizon than at the zenith, where no such comparison with distant objects can be instituted, it does not prove *how much* that increase would be, or whether it would be *as much* as the phenomenon presents. The demonstration is not exact or quantitative, it will be observed, however proximately true. It does nevertheless account for part of the phenomenon,

if not for the whole, and should be made as clear as possible to the untechnical reader.

To the most untechnical, then, it need hardly be premised that the further any object is from the observer, the smaller it appears, or, in other words, that it subtends a smaller angle. It is also known to every observer that no permanent objects with whose size we are familiar, can be seen at full length on the zenith; and though the tops of high buildings and trees may be so seen, yet as these seldom reach more than a hundred yards in height, they could not be seen on the zenith at a greater distance than this, and would consequently be very little diminished to the eye, in comparison with objects three miles away on the horizon. Now, if we look toward the zenith at noon, and see the sun in the clear sky, no building, etc., being near, it will look relatively small from being surrounded by so large a space; neither will the proximity of clouds much assist us in assigning to it a definite magnitude, seeing that the size of the clouds themselves is unknown to us—whilst if we stand next to a high house, so as to see the same noon-sun shining over it, it will not look larger than an ordinary stack of chimneys, for by stooping a little we shall indeed find them obliterate it; or, if we stand under a high tree a small bough will be sufficient to do the same. So that, under such circumstances, we should familiarly say the sun looks no larger than a chimney-stack, etc., or, we might add, the outstretched hand, which would obliterate sun or stack equally. This would be said of the sun at noon; now of the sun on the horizon, which, be it remembered, occupies the same space on the eye. Let us look down a long street, commanding a view of the horizon, on a fine evening. The houses, as they recede down the street, grow gradually less and less to the eye, till at last the outstretched hand will as easily hide six of these at the horizon, as, formerly, it hid the chimney-stack at the zenith. The sun sinks slowly behind these houses, growing larger and larger as it descends, till when it has half disappeared, we shall see the remaining half actually arching over, and spanning four or five houses! Now, whilst we felt that the noon-sun looked no larger than a chimney-stack, we feel that the setting sun looks larger than four houses. True, if we measure it by the outstretched hand,* it looks the same in both cases; but then this is not the object with which we usually compare it, and it is the known size of one object that gives an idea of the unknown size of another in its vicinity. It should be borne in mind here, by those who are not used to these subjects, that a finger-nail only, brought nearer to the eye, would be as efficient an obliterator as the hand, further off. This is the sum and substance of the first solution of the phenomenon, which takes no account of mists, etc.

The second solution, based on the greater density or mistiness of the horizontal atmosphere, may appear somewhat misty to the uninitiated in these subjects, and is, therefore, even more unpopular than the first. But since, as we shall show (with the reader's patience), this mist, when present, must have more or less to do in the augmentation of the phenomenon, it is most important that we give it some attention. To begin, the air is always more or less impregnated with vapours: and the greater quantity of air, the greater quantity of vapour; or the further an object is off, the more vapour between it and the observer: distant objects are therefore more obscured than near ones, if (as we know somewhat too well in this climate) the property of vapour is to obscure. As a general rule, then, the obscuration or mistiness of an object is an exponent of its distance: the greater the obscuration, the greater the distance is supposed to be.† But

* The outstretched hand is much larger than necessary, the finger would do but for the sun's brightness.

† In clear climates, and Italian paintings, distant mountains and buildings look nearer, more distinct,

this rule or guide as to distance is only a rule and guide under such conditions as we have been used to, and whence, indeed, the rule was eliminated: alter these conditions, the rule is no rule, and the guide is no guide except a false one. The writer remembers that when young he used to pursue his recreations in a plain where there stood a considerable mound of earth from twenty to thirty feet in height. Now the autumn weather had been unusually clear, when approaching the scene of his gambols one morning, just when the mists were beginning to set in, this mound appeared, to his astonishment, of awfully vast dimensions; gave him the idea, in short, of a real mountain, such as he had only hitherto wondered at in picture-books: it was a *mountain*, but a mountain *a long way off*. Now it will be observed that the same apparent inconstancy of rule applies here as in the former case, where the apparent size of the sun depends on the distance or nearness of the object with which it is compared: still the rule is constant where the conditions are so; and if the general rule is undeviating, "that the smaller the same object appears in angular measurement, the more distant it is;" so the general rule is here equally undeviating, "that the more misty an object looks in the same atmosphere, the more distant it is."

When we next consider that the densest layer of vapour is nearest to the earth, the less dense immediately above it, and the least dense highest of all, it is plain that in looking to the horizon, along the earth's surface where this vapour abounds, that an object seen in this direction will be seen through the greatest possible quantity of vapour; and that an object seen directly overhead will be seen through the least possible quantity—least possible with respect to a person standing on the earth; and, therefore, that of two objects equally distant from the eye, that which is seen overhead will be much less obscured than that seen in the direction of the horizon; and as objects approach the horizon they will grow gradually more obscure, and *vice versâ*. If, then, on a fine cloudless night, when the heaven is full of stars (the relative distance of which we have not the least notion of, by immediate sensation), we look at a star that is on the horizon, and scarcely visible in misty haze, and then at one in the zenith, flashing clear and bright, we cannot resist the conviction that the last is nearer than the first. The stars intermediately situate follow the same rule, and conspire to form not any part of a hollow sphere, but part of a hollow ellipsoid. Now this rule, being constant (urge the advocates of this solution), applies equally by daylight: the tops of mountains and high towers, we may add, do certainly appear nearer than their bases, these objects being seen from a distance.

We have then this general result; that where objects, such as the sun and moon, which are experimentally beyond our sensory power of admeasurement as to true size and distance, are seen upon the horizon, they necessarily appear more distant than in the zenith. But since objects far off appear less, or take up less space on the eye, than the same objects near, when we feel that they are further off (from their mistiness) we naturally expect them to occupy less of the field of vision. The dim horizontal sun, therefore, looking further off than the clear sun of noon, our sense of vision demands that it occupy less space thereof, and this not being the case, the sense flies to the only alternative, that this object is actually larger. Though the mind ignores it the sense feels it nevertheless, for the sense cannot but trust those constant evidences which are guiding it all day in forming its estimate of every new object that presents itself. Imagine a balloon in the sky which (from its indistinctness and misty ob-

and smaller in comparison with what we are accustomed to see in our more vapourish atmosphere; yet, once familiar with it, we find this finer obscuration a still subtler exponent of distance, as it need be, indeed, when the distance seen has become so much *increased in reality*.

scuration) must be referred to a great distance, at the same time occupying as much of the sky view as another balloon clearly close to us, and it is impossible, with our senses thus constituted, to resist the conviction that the first is a great deal larger than the second.

Some of the supporters of this view (Mr. Barlow, for instance) have, perhaps, stated it somewhat differently. They rest upon the fact that the effect of atmospheric horizontal density (already described) causing the eye to refer the heavenly bodies to a concave much nearer to the observer at the zenith than at the horizon (they compute, three times nearer*), is a permanent consequence resulting in a conviction that the sun, moon, etc., are actually seen on such a curve: that all objects, in fact (not earthly), will be judged further off when seen in the direction of the horizon than when seen in that of the zenith, and that this would still be the case even if by some accident they should appear equally clear in both directions:—though when we reflect that the guide to their assumed distance was derived solely from the fact of their obscurity, in the self-same manner as the guide to distance of earthly objects was derived from theirs; and that these last, moreover, when they appear unusually clear in the horizon do actually appear nearer in consequence; it seems difficult to admit this assumption without some further evidence.

These are the two grand solutions, both, in some degree, unquestionably correct, inasmuch as they account for some part of the phenomenon. And whatever the advocates of the first may advance in disparagement of the second, the astute Berkeley has certainly established the claims of the latter to consideration, by observing how the sun or moon setting in mist appears always larger than ordinarily; a phenomenon, the holders of the first solution cannot, we think, account for by their unaided argument. And it might further be observed, to the same effect, how painters (of an unwise ambition) are in the daily habit of rubbing a little semi-opaque pigment (the pictorial equivalent of mist) over such objects as they wish to *recede*, thereby in technical language, "sending them back" bodily, but without that nice observance of texture and degree which ought certainly to direct the aim of a true artist, and for which Mr. Holman Hunt and his followers were at first condemned:—at *first*, for the demand of the senses is conditional, whether in Art or Nature: this *too great* mistiness *was* the condition of pictorial distance; but we are now beginning to recognize the identity of Hunt's distance-condition with that of Nature, and shall still further recognize it when his chaste and accurate delineating of Nature shall have induced us to study her more observantly.

On the whole, it cannot be admitted that this second solution is, as it has been the the fashion of some to estimate it, less scien-

* "Three times nearer." The supporters of this theory affirm in proof of its veracity that if we endeavour, by eye, to divide the angle between the zenith and the horizon into two equal parts, we invariably assign a much smaller angle to the lower half of the quadrant, or, in point of fact, *fail to halve it*. And this they account for by supposing that since, according to their hypothesis, the imagined concave grows ever more distant as it approaches the horizon, we seem to require a smaller angle to measure the *same space* thus seen at a *greater distance* (apparently)—or, in other words, that we are halving the concave, while we think we are halving the angle; they state, in effect, that we assign an angle of 23° or 24° to the (supposed) lower half. Now while it is difficult to believe that any two pairs of eyes can be so geometrically true as to agree, in this point, to the nicety of *a degree*—a statement in itself suspicious—it naturally occurs to us that the general fact of the unaided eye attributing so much less than 45° to the lower half of the quadrant may be easily accounted for by the *absence* of a defined zenith and the *presence* of a defined horizon causing us to resort to the latter as a guide to one limit (at least) of the angle we are attempting to bisect: so that when the eye glances upward to take in the zenith, which it never can do while it sees the horizon (the angle being much too great), and is constantly drawn back to the horizon, as we have shown, it naturally and necessarily places the half of the angle it *does* see nearer to the horizon than the zenith, and for the simple reason that the *angle seen* really is so situate.

tific and tenable, however less obvious to the senses it may be, than the first. It to some extent accounts for one excessive manifestation of the phenomenon, namely, under the condition of extraordinary mist, which is not accounted for by the first solution; and it may, moreover, supply other shortcomings of the same in respect of a difficulty of explaining how the sun setting on a sea offing, where there is no known magnitude to measure it by, does, nevertheless, present the same enlargement; for, although it has been answered to this objection that the line of the offing is the measuring line, the question then arises why an artificial horizon or offing, in the form of a straight board set up with its upper edge immediately beneath the sun *at noon*, should not present the same measuring line, and make the sun appear larger? Whilst, if we reply to this that the gradual diminution of the waves toward the offing confers on it, however indefinitely, an imposing perspective magnitude, while the artificial offing wanting this property, it being indeed of a known length necessarily very inconsiderable, is virtually no more than the bough of a tree, a chimney-stack, or outstretched hand; how, in the next place, if we grant all this true, shall we be able to explain why such artificial offing, set up before the natural one and so as to hide it, will not, and does not indeed, make the setting sun appear of its noon-day dimension? It seems that in one or other of these cases we must admit a shortcoming, at least, in the first solution, which is certainly supplied in some degree by the second.

And now, if it is clear that the supposed necessary condition of greater density is always present when the phenomenon occurs, but that the supposed necessary condition of comparison with large dimension is not always present when the phenomenon occurs notwithstanding; and if it is clear, moreover, that both these conditions, when present separately or together, must always have some of the effect attributed to them; it might at first appear possible to ascertain their relative value by observing and measuring what amount of deficiency the phenomenon exhibited in the supposed absence of one of these. Yet this seems no easy task. Mathematical measurement is useless, excepting to prove that the luminary is always the same size in all parts of the heavens. The testimony of observers differs, through the medium of sensory experience. One affirms that the sun setting at sea looks larger than on land; another eye asserts the contrary; and they only all agree in this, that the sun setting, wheresoever and howsoever, always looks larger than when it is at noon. Now, the inevitable conclusion from such evidence means manifestly this, namely, that though, as we have stated, both the solutions offered must have some weight, they can by no means, separately or together, fully account for the phenomenon, seeing that the absence of an agency demanded by the first solution is not always detected, that this agency is (by the highest authorities) held quite as instrumental as another agency supposed in the second solution, and that the united operation of both agencies makes no generally admitted difference.

Now the case seems to stand precisely in that predicament wherein the Scriptures were presumed to stand, in consequence of each sect of believers doubting some point which another sect believed. Science, however, cannot recognize the logic of this kind of conclusion, is logically justified in believing both solutions, and detects no error excepting in the determination to receive one and reject the other. Both have unquestionable worth, though there may be some further revelation to follow; and when it is remembered that there is nothing exact or quantitative attempted in either of these solutions, there is nothing to discourage a further analysis.

Before, however, any such analysis can be ventured—indeed, before any analysis whatever can be entered on with rational prospect of success—it is essentially necessary to determine, by a comprehensive survey of the subject, as to what tests appear most likely and promising. We should endeavour, also, to ascertain, if possible, where the test should be applied; what part of the subject is known; what part unknown; what test it was that conducted to the known; what test failed in the unknown. Let us consider.

In the first place, the increased magnitude of the luminary is only an appearance: the phenomenon does not exist until after the rays which present it to sight have entered the lenses of the eye. This is proved by the already elicited fact that, in whatever part of the heavens, the luminary always impinges upon the eye's outer coat under the same angle of subtense: it is the same size in a camera.* This reduces the question to two possibilities: the illusion is either organic or mental. Something *may* take place in the organ which produces the illusion, or the mind may be solely the responsible agent. True, former inquirers have taken it for granted (for the reasons given) that the latter must be the case; but no one, to our knowledge, has proved this: and though it eventually may be proved, it is most important that it should be proved unequivocally before we spend time, or possibly waste it, in this field of inquiry. If we could certainly know that the image of the luminary is, in all cases, the same size on the eye's last and sensitive coat, there would then, indeed, be certainty that the passage of the image through the organ had not made it larger—that the illusion is strictly mental. It is this that I propose to establish through the agency of a fact well known to physiology, though seldom resorted to in questions beyond the pale of that science; and I have chosen rather to call this a new analysis than a new solution, inasmuch as the solution itself, however hitherto unknown to the writer, may possibly exist already, though, he submits, without the same amount of proof. A few words, by way of introduction, about this physiological agent.

* Refraction not considered.

Upon waking in the morning, or after long rest in darkness, the nervous coat of the eye is peculiarly sensitive, and will retain bright images impressed upon it for a considerable time. Look, immediately upon opening your eyes before rising, toward a window facing the east, and, on turning them away to some dark corner of the apartment, you will perceive a more or less perfect resemblance of the window-sashes, which spectrum, as it is called, will now follow your gaze, and even remain visible for some time after the eyes are closed. This spectrum is merely the *leavings* of a pressure of light upon the retina, resembling in all respects the sensation of pressure from a coin, say upon the hand, for some time after the coin has been removed, and purely a physiological phenomenon, having nothing to do with memory.

It was some years ago, a moonless night in autumn, that I happened to be rambling with two companions in a somewhat unfrequented part of Kent, and nearing the limestone range which makes itself visible at Wrotham. Lights were wanted, and the votaries of Nicotiana had no means of procuring them. One of the party, however, noticed an occasional glimmer over the hills, which, considering the nature of the ground, suggested the comfortable idea of a lime-kiln not far off; the road also descending through the hillside strengthened this conviction, and presently brought us, by a dark cutting, to the desired object. Our wants being supplied, up rose a most civil Cyclops to give us a sight of the furnace. It was a stroke, an iron clang, and a burst of fire that almost blinded us. I, who had never before seen

this Vulcanian wonder, was, I remember, fairly fascinated, and stood gazing at the incandescent circle, with its tongues of flame curling and gyrating round a central core of brightness, till my friends had reminded me of the lateness of the hour, and the need of hastening if we meant to have lodging for the night. Now, to say that a smoker in the dark cannot tell whether he is smoking or not must be a mistake, for we unquestionably kept our lights, the wise virgins not more scrupulously; but as for seeing, I can vouch for myself that I saw nothing but a great white circle of fire in whatsoever direction I looked; and if it was a dark and difficult matter finding our way here, it was ten times more difficult finding it back again, with a golden fiery disc swimming always in front, and taking the very ground from under us. Slowly, however, we felt our way up out of the cutting. I have said that the road lay on the hillside, and that the evening was unusually dark, notwithstanding which latter we had, hitherto, seen some glimmer of a landscape in the valley below, which now was all blackness, the difference between earth and sky not being more than that dim difference which exists between a surface blackened with the deepest vegetable-black, and another less blackened with Indian ink. The horizon was only discernible, and along this horizon, as I tried to follow it, moved the bright disc I have described; when the eye rested, it rested presenting the appearance of a rising or setting sun, as I thought, and, thinking this, I looked up. It was smaller, about half its former diameter. I then looked directly to the zenith, and the diameter of the disc appeared reduced about a third. I ventured this computation after immediately looking back to the horizon, on which it looked about tripled (to my judgment), though, of course, there was no means of measuring it exactly. I will say, however, that the apparent difference between the rising and meridian sun was so singularly simulated hereby, that, supposing any difference of relative proportion, I should be quite at a loss to state it.

Here, then, the problem was so far solved. The same image stamped upon the eye's sensitive coat was estimated larger or smaller, according to the direction in which that image was seen. Comparison with objects had nothing to do with this, because no objects were visible. The difference, I have said, between earth and sky was only just discernible, and merely sufficient to give a notion of direction. Mists, also, had they been ever so abundant, could not have acted here it is manifest; neither could the lenses or machinery of the organ, since the phenomenon was here exhibiting itself behind the organ, and utterly irrespective of it.

We have thus materially narrowed the field of investigation; but before any attempt is made to analyze what remains, it would be well, perhaps, to state the result of another experiment, or experience rather, since design was absent in both cases. I was walking with a friend, before sunrise, on the high ground overlooking Sydenham, greatly fatigued, having been reading late overnight. We sat down looking at some ferns growing near, and were talking (what we did talk) quite beside the present subject, on the more earthly one of botany, I believe, when presently the sun rose, in no gorgeous drapery of clouds, but moderately clear, over a low line of vapour; so ordinary a sunrise, indeed, as not to awaken us from our lethargy, or call for any remark even from my friend, who was an artist. I saw it, and looked back vacantly at the ferns again; but turning presently to the sky, I saw three or four spectra of the sun floating along the horizon. They were in all respects the same, in size and shape, as the sun itself, the only difference being that they were now going through their changes of colour from gold to purple, and back again to gold. As I looked higher in the heavens these became

smaller and smaller, and, on looking down again to the horizon, increased to their former size. I now woke up suddenly. Looking intently at the sun, and telling my friend to do the same, we waited till its now brighter disc had somewhat painfully excited our already-fatigued retinæ. We then looked rapidly up to the zenith, where we both at once saw a brilliant and well-defined spectrum of the sun, seemingly of the same size as at midday. My friend attested this fact most emphatically. I now asked him, without looking to the real sun, to turn round. We did so; and gradually lowering our sight to the western horizon, we both of us saw the spectrum gradually increase till it rested there a perfect sunset. On looking upward again, this spectrum ever diminished. It was now a veritable experiment, and we repeated it several times, always with the same effect.

Now, I feel the more justified in trusting the faithfulness and accuracy of these and following observations, seeing that when they were made I had myself formed no theory or design of any further solution. I was satisfied with one of the explanations given; so much so, indeed, that when I wrote a short paper on the subject of these observations it was merely in verification of the theory adopted by Sir J. Herschel, so far as it attributed the phenomenon to mental causes, and recommending the employment of spectra as an available analytical agent. The paper was written some years back, laid by, and forgotten; but on turning it up lately, and looking over the subsequent observations referred to, there appeared a difficulty in reconciling all the evidence with either or both of the received solutions as absolute and full. The present theory, therefore, as far as the writer is concerned, is strictly founded on these observations, and not these observations upon it.

They are, first, that the sun setting in absence of objects having known or definite magnitude, as over a calm sea, or plain void of buildings, etc., does look much larger than when seen at the zenith. This is constant.

Second, that the sun setting at the end of a long street, where the buildings gradually diminish to the horizon, looks larger than at ordinary setting.

Third, that the sun looks larger than ordinarily when setting in unusual mist.

Fourth, that an artificial horizon set up under the meridian sun does not make it appear larger.

Fifth, that obliterating the horizon and buildings does not make the setting sun appear smaller.

Sixth, that a spectrum of the sun, or like body, looks larger when seen in the horizon, in the same proportion as the sun at its ordinary setting, or much larger (about three times diameter) than when such spectrum is seen in the zenith; and this in absence of all objects of comparison.

Now, the progress of the analysis may be thus stated:—

First, the luminary, in whatever part of the heavens, is always the same size when it reaches the eye, as proved by the sixth observation, as well as by mathematical measurement.

Second, the size is not altered in its passage through the organ of vision; or, the luminary, wheresoever situate, is always the same size on the retina (the eye's sensitive coat), as proved by observation sixth.

Third, the mind always regards this image as much larger when referring it to the lower part of the heavens (observation first).

Fourth, the mind estimates the image as still larger when comparing it with distant objects, the size of which is known to be large (observation second).

Fifth, the mind also estimates the image as additionally larger when it appears misty,

or less distinct than usual (observation third).

The phenomenon, therefore, has become strictly mental; and it is not simple, as we supposed at starting, but threefold. Firstly, and principally, the luminary always looks much larger on or near the horizon, in absence of the causes attributed by the first two solutions; and secondly, and subordinately, it assumes a still further magnified appearance, under two various and accidental conditions set forth by those two solutions. It remains, therefore, to be explained why the self-same image of the sun or moon upon the retina is supposed by the mind to be of various sizes, according to a supposed position in the heavens, simply and without reference to mistiness or objects of comparison.

Now, since it is granted, by every authority, that the *same image* upon the retina is felt to be larger or smaller accordingly as it is felt to be further or nearer, we have only to assure ourselves that the retinal image in question is felt to be further off when in the horizon than when in the zenith, and the solution is found.

We say "*felt* to be further or nearer," for it is mental feeling, not reasoning, we have to do with. A well-painted ball is felt to be round and spherical, though we *think* and *know* it to be flat; and we *feel* this image of the luminary to be larger, while we *know* at the same time it is not so. If, therefore, we consult our *feeling* with respect to the surface of the heavens above us, we shall all of us agree that we feel it to be vaulted. Whether cloudy or clear makes no difference, it is a vault still. We not only feel, but call it so. If cloudy, it is the "vault of vapours;" if clear, the "blue vault." Appeal to any unlearned person, and ask him which is the *near* sky and which the *distant*. He will point over his head to the first, and on to the distant horizon to the second. And this is by common consent, for the learned will do the same upon the impulse of his feeling; and we have to do with feeling fundamentally to account for an æsthetic phenomenon, or one of the results of feeling. Observe here we have nothing to do with objects, size, mistiness, or any other particular or appreciable quality of matter, save distance. Let the view be clear, cloudy, misty, at sea, on land, with buildings or without them, the rising sun is *coming to us*, and further off than it will be at noon; and the setting sun is *going away* from us, and more distant. We are not in this question bound to consider anything beyond the common testimony of the senses. It is enough that, from some cause or other, not only the sun and moon, but the heavens also, appear further off at the horizon: it is amply enough to account for the phenomenon, when it is remembered that the image on the retina is always referred to the surface we see it on, provided such image possesses nothing to express its real distance, and nothing the size of which is known to the sense. The sun and moon, therefore (the size and distance of which are not known to sense), being always seen upon the vault of the sky, will appear further where that appears further; but appearing further off, and yet occupying the same space, will be judged larger, just as a figure a long way off in a landscape, if it measured the same as a near figure, would appear a giant.

We have now traced the cause of the retinal image looking larger, to a known and admitted fact, namely, that the vault of heaven is felt to be more distant at the horizon. If now it is asked why this is felt, and whether the feeling is a correct one? the first question is only seeking a more remote cause of the phenomenon, and the second, however answered, will not affect the truth of our solution, since, be it remembered, the feeling that the luminary is larger in the horizon than in the zenith is anything but a correct feeling. Let us now consider

why this is felt, and if the feeling be correct, by way of supererogation.

Why does the vault of heaven appear more distant at the horizon than overhead?

What do we mean by "the vault of heaven?" It is something that we see, undoubtedly. It may be clear sky, without any configurations or appreciable parts; it may be broken with clouds of a definite shape; or it may be an unbroken and homogeneous sheet of cloud or mist; but it is always a surface that we see, that the artist, in fact, depicts under one or other of these phases, and ever as a concave surface or veritable vault. How does he depict this? If with dots of the graver, these dots are smaller, closer together, and more numerous near the horizon than they are where they approach the zenith; if with colours the particles of pigment are more or less mixed, so as to follow this rule. The painter's process, indeed, is an exaggeration of Nature's, but only as a difference of degree, not of kind. There are particles in the atmosphere sufficiently opaque to reflect light to our eyes, or we should not see even the indefinite appearance it presents, but only the blackness of space; while the fact of our not appreciating the black dots of space between these opaque reflectors, witnesses to their infinitesimal minuteness and closeness; as the fine dots of the graver are not *appreciated as such*, but *seen* still as a tinted concave. Now with the question of more or less light, obscurity, definiteness, or cognizable dimension, we have nothing to do; if we see at all we must see something, and that something must be somewhere. What this something is, we have said; indefinite and minute reflecting particles. We next ask, Where is it? Everywhere, even to the confines of our atmosphere; but the grosser and better reflecting particles nearer the earth, and the finer and worse reflecting particles further away from it. The atmosphere may be represented by a number of concentric shells or layers, the internal still growing denser, or the densest nearest the earth, which is their nucleus; the best reflecting particles forming the innermost shell, the worst reflecting, the outermost. All that light surface we designate the vault of heaven is produced by some or all of these concentric layers of reflectors. It *may be* in a clear daylight sky the particles of the furthest layers make *some* impression on the retina, and it may be on a night such as that when our spectrum was seen, that the furthest layers visible are a great deal nearer. But how far distant soever the particles which are capable of affecting the retina, the concentric arrangement of various densities must ever result in a vault or concave, concentric with the earth. This, then, is the "vault of the sky," enlarging with the quantity of light, as we feel indeed to be the case when we seem to see further into the air in light than in darkness. If, however, the stratified course of the atmosphere resolves itself into the inside of a sphere concentric with the earth, it needs no diagram to show how the distance from an observer on the earth's surface, to any layer in the direction of the horizon is far greater than from the same observer to the same layer at the zenith. It appears, therefore, that the somewhat poetically named vault of heaven is a reality nevertheless, and that when we see it in the horizontal direction it is much further off than when we see it at the zenith. But if it *really is* so, how do we, without any reasoning, know and feel this? To answer this question, let us consider *one* of these layers. The particles of which it is constituted will be more close and numerous as it approaches the horizon. But these particles cannot be appreciated, neither can the dots of the graver at a little distance off, but they are, nevertheless, seen as a tint, and appreciated as a tint retreating; and this layer of atmosphere is appreciated as a retreating layer, though the intertexture of its

particles cannot be distinguished individually. In short, it is not more surprising that we discern the relative distance of a stratum of atmosphere than that we discern the atmosphere to be stratified, and not more surprising that we see it stratified than that we see it at all; whilst that we do see it is proved from the fact that did we not see it we should see blackness in its place. But, says our respondent, these reflecting particles are mist, not atmosphere, and mist was to have been excluded from the question. True, this may be so chemically, but we have to do with the atmosphere as we find it, and if this property of reflecting be owing to mist in the atmosphere, as we have not ascribed to it any of that obscuring influence for which alone it was to be omitted, we have virtually omitted it; for in like manner it might be argued that the particles of atmosphere are *objects* (also to have been omitted), but as we have not invested these with any assignable magnitude or appreciable individuality they are no more *objects* of *comparison* than they are indeed of *obscuration*. But even though pure air may not be, our atmosphere *is undoubtedly seen*, manifesting itself as tint, colour, etc. (as already explained), and the concave figure and relative distance of this is seen simply by the same laws which exhibit the shape and distance of all things, to wit, of a dome of tissue or fine cloth, the texture of which may be too minute for appreciation, while its concave arrangement and relative distance are nevertheless appreciated under the presentment of tint and colour. Moreover, when it is considered that the course of the clouds, which for the most part follow the course of a layer of atmosphere, whereon they float while they retain their identity, gives us the same evidence of the curved surface supporting them that the course of objects floating upon water gives us of the surface of the water; we have another important argument of the truth of our common conviction when it attributes this form and relative distance to the heavens.

Lastly, if we imagine in place of the atmosphere a number of concentric layers of glass, the grossest and least diaphanous immediately over our heads, and the purest and most diaphanous situate at the boundary of vision; can we suppose that the form of a dome would not be appreciated by the eye, to whichever of these layers it be directed? And the question of more or less light (formerly referred to) will, under this supposition, have nothing to do with the appreciation of form; for though the light be never so little it must come from one or more of these reflectors, and coming from these it will exhibit their form and relative situations in the same way that it exhibits the form and situation of everything else that reflects it.

If, then, this vault of the heavens is (as it seems to us demonstrated) an *appearance* as well as a fact, the sun or moon which is necessarily referred to it will appear much further off on the horizon than at the zenith, and (occupying the same space on the retina as it does when at the zenith) it will consequently appear much larger than when seen at the zenith; and this without assistance from misty obscuration, or comparison with objects of appreciable or foreknown dimensions—facts which undoubtedly account for a further apparent enlargement not uncommon in misty climates and under particular conditions.

The object of this paper is not so much to establish the truth of this or that theory, as to exhibit a peculiar advantage derivable from analyzing the phenomenon subjectively as well as objectively:—to recommend, in fact, the adopting of a similar mode of treatment in the investigation of all phenomena whatever, wherein the participation of the mind and senses cannot be disputed.

Guy's Hospital. ZENO.

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MY MICROSCOPE, AND HOW TO MAKE ONE LIKE IT.

THE object of this paper is to place it in the power of almost every one to obtain a useful and scientific instrument for the same money nearly as that for which a comparatively mere toy is obtained at an optician's.

Object-glass.—Take two plano-convex lenses (they have less aberration than double convex), one of about half an inch focus, and the other of about one and a-half inch, and set the smaller (of the half-inch focus) in a small box or deep ring of pasteboard (half dram and dram pill-boxes answer well), about one-quarter of an inch or rather less in depth, and with a bottom to it in which is a very clearly formed hole (if the box be card, burning is best) about one-sixteenth of an inch in diameter; put in the glass (having previously cleaned it with wash-leather) with the plain side downwards, next the hole. Inside the box fit a rim of card, of a height equal to the thickness of the glass, and leaving (of course, as it would in a box half an inch wide) a small space in the outer rim (see dotted line in Figure). On this rim fix a round bit of card with another hole in it a little larger than the other. This is called a diaphragm or stop, and on this, flat side down, place the one and a-half inch focus glass. Now fit the whole into another box with a hole about three-sixteenths of an inch in diameter, or one-third of the diameter of your upper glass, and you have a simple microscope of great power, which will make a small square the one-eighth of an inch in diameter □ look half an inch, and type of the size called "pearl" half an inch long and thick in proportion.

Note.—The *nearer* the glasses the longer the image, the *longer* the focus. The *further*, the less the image and the *nearer* the focus. They must not be removed further than the distance of half their combined foci. You might make combinations of this kind of glasses of $1 + \frac{1}{2}$, $\frac{1}{2} + \frac{1}{4}$, $\frac{1}{4} + \frac{1}{8}$, diminishing the aperture as the power increases.

This little apparatus will form object glasses for the *compound microscope* about to be described.

The compound microscope is, so to say, a combination of two simple ones, of which the one, if double and of different powers, with the high powers placed close to each other as above described (the *greater* being *next the object*), forms the *compound object glass*, and another of lower powers placed further (*i.e.*, at the long focus) from each other, the *higher* magnifier being *next the eye forms the compound eye-piece.*

The glasses are respectively named, thus

That next the object, the *Object-glass.*	} Object-glass.
The next up, the *Enlarging Lens.*	
The further one from the eye, the *Field Lens.*	} Eye-piece.
That next the eye, the *Eye-glass.*	

The compound microscope, therefore, consists of the *eye-piece*, the *tube*, the *object-glass*, so far as the instrument itself is concerned; but as to hold such an instrument steady enough for use would be impossible, it has also a *stand*, a *stage* to place the objects on, a *mirror* to illuminate from below, a lens called a *condenser*, and sometimes a *reflector* attached to the object glass to illuminate the object from above.

The microscope is *common* or *achromatic.* We shall first describe the most simple form of compound microscope.

The *Eye-piece.*—Take some pasteboard and make some tubing, about one inch in diameter, by rolling it round a ruler. Make another size which fits inside this; and again

another size which fits outside it, by rolling it round the latter. For the middle size marking-ink bottle cases or hair-pin cases are excellent. Black them all inside with lamp-black and water colour. Buy a three-inch focus plano-convex, and also a one-inch. Let the three-inch be such as to fit your middle-sized tubing, *i.e.*, about one inch in diameter. Cut off a portion of the tube, about three-quarters of an inch in length, and fit your glass into it, with the convex side outwards.

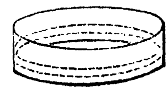
Let the inch focus glass be about half an inch in diameter, and fit it into a small pill-box, with the plain side next the lid, which should have a very central hole in it, about one-fourth or one-third inch in diameter, and, of course, be blackened inside. Now fit this little box, lid and all, into a piece of the smallest tubing, about one inch long, and off the next size cut about an inch and a quarter, and at one end glue a round card, with a hole in it about half an inch in diameter. Cut a piece about two inches long off the largest tube.

Now slide the three-inch glass with its tube into one end of the above piece of tube; next insert, at the other end, the box with its diaphragm, next to the other piece of tube containing the glass, and into this latter insert the eye-glass in its tube.

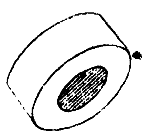
Now the rule is, that one glass being three inches focus, the other one, the distance between them should be two, or equal to half the united foci, and the stop about one inch from the eye; but as you never can exactly measure the focus, I have preferred to make both glasses and stop moveable. And now attend to the adjustment; look through the eye-piece, and if the field, or large white disc be clear and good, then there is nothing more to be done; but if the field be fishy and indistinct at the edges, slide the different pieces to different distances till it be clear. Try the stop a little nearer the field or outside glass, then a little nearer the eye-glass, then draw out the eye-glass a little, then the field-glass, and so on. When you have a clear field, like slightly ground-glass, it is good. But now there is another thing to be attended to, if the rim round the field be *yellowish* or orange, slide the eye-glass in a little; if *blue* draw it out till you get a neutral Indian inky rim, and the adjustment is made. Lastly, put a cap on the top with a hole rather less than the opening of the glass, and about half an inch nearer the eye than the glass itself, to keep the eye at its focal distance, and prevent obscuration, diminishing of the field, etc. This cap is necessary for a low power, because its focus is longer than the higher powers, and the eye should be kept at that focus, as when it approaches too near the disc is overshadowed. In high powers the focus is so close that the eye does not require to be kept away further than the width of the brass or pasteboard.

This will be the eye-piece of low power. Now for the higher. Take an inch and a-half plano-convex, the size of your second-sized tube, and having cut off about half an inch of the tube, fix it in with the curve out.

The better to fix it, put a ring of strongish brass wire on each side the glass, one inside, the other out.



Then make a stop, with a hole about half an inch in diameter, fixed in another bit of tubing of the same size, and place the stop next to the glass, above described;



then put these in this order: first the stop, with perforated disc next the glass; then the tube with the glass, convex outside, into a bit of the largest tube one and a half inches long.

Then cut a bit of the second-sized tube, and put in at the other end, about three-quarters of an inch long; then into this put a bit of the third-sized tube into it, about

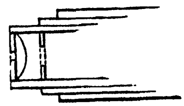
three-quarters of an inch long, with glass fitted (plain side next eye, *i.e.*, outside), and cover it over with a round bit of blackened card with a hole in it, about $\frac{1}{16}$ of an inch diameter—adjust as before, till you get a clear neutral-edged field; and that will be the high power eye-piece.

Though the whole is properly called an *eye-piece*, technically (as before stated) the further glass in the micro- or tele-scope is called the *field-glass*, and that next the eye the *eye-glass*.

Now for the tube. We have already three different sized tubes. You must now make a fourth, by rolling pasteboard round your largest, and when done cut off a piece about six or seven inches long, or eight if you like. The longer the tube the larger the object with the same powers, but a little darker or obscurer; I should say seven inches was long enough for glasses of the diameters above mentioned. Now in one end of this place the eye-piece, having first put in a diaphragm with an aperture about $\frac{1}{6}$ths of an inch, about a third of the way up from the bottom, or part of object-glass, of which we are now going to speak.

The object-glass, being the principal part of the instrument, requires the greatest care. This is either *simple* or *double*, made on the principle just described under simple microscopes. A 2, or 1, or $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, etc., inch, might be placed in a little box, and fixed in your least tube, surrounded by the other tubes till you come to the largest, which fits your microscopic tube, leaving the least projecting a little for symmetry's sake, as well as convenience—not to have an immense end to the microscope, preventing your seeing the object when looking down on it from above, and obscuring the light of the condenser, especially in high powers, or closer foci.

The interior of the little box in which is the glass should always be on this portion, the holes being larger as the power is smaller; small hole at end; glass plain side down diaphragm.



But to the single glasses is attached much chroma, or colour, the edges of the object not being clear and coloured.

To make a double object-glass, called achromatic or colourless, take an inch plano-convex about a quarter of an inch diameter, and place it in a small box with a hole about $\frac{1}{16}$th of an inch in diameter, plain side down next hole; round this place a small rim of pasteboard inside, equal to the thickness of the glass; some put a stop with a *small* hole immediately behind this first glass; otherwise make a *large* hole, so that it becomes a ring for the next glass to rest on, then place on this (either stop or ring) another glass two-inch focus, and over this (having put a ring round it, as high as its thickness) place a stop with a hole about $\frac{1}{8}$th of an inch diameter for low power object-glass; and make another object-glass, with a $\frac{1}{4}$, and a $\frac{1}{}$ or $\frac{1}{8}$, and a $\frac{1}{4}$, for higher power, in the same way as the other—only the *holes must be less as the power is higher*. The focus of the first of these will be about $\frac{3}{4}$ of an inch, of the second about $\frac{1}{4}$; of the $\frac{1}{8}$ and $\frac{1}{4}$ about $\frac{1}{16}$ of an inch.

But though a more achromatic field and greater power are thus gained, I should recommend every one to procure at an optician's a triple achromatic object-glass already made, and turn a little box-holder in which to insert it. Then you have three distinct powers, the strongest of all three, the second with two of them, and the third with only one. There are small foreign object-glasses, very cheap, and ten times clearer than can be made with simple plano-convexes.*

* I have procured one of these at a very moderate rate from a London optician, and it has succeeded

These little object-glasses already described, especially the last, will show the direct, and some of the transverse lines on the scales of the wing of a common clothes-moth, *Tinea vestialis*. They will define the *Navicula* and the *Podura* scale; the *Lepisma* perfectly (being much larger). They will also show the *Coscinodiscus*, the *Aulacodiscus formosus*, the *Triceratium*, which are good tests; but the scale of the common moth is perhaps one of the best, except the *Naviculæ*.

The simple compounds of plano-convexes require immense care, and though they show photographs well, and most of the ordinary things required, they seldom succeed in defining the finer lines of high tests, or at least, after much time and attention bestowed on their construction, they have not done so with me; though Brewster ("Optics," pp. 342, 343) says Dr. Herschel's doublet of a double convex equal to about one inch, and a meniscus with convex side towards the less convex side of the double convex, *will show all tests*.

I can only suppose it showed those tests *then in use*, or that not having compared them with the compound achromatic, the learned author was hardly aware of the vast difference of appearance.

The transverse lines on the scales of the moth I have never seen *perfectly*, except with a first-rate instrument; ordinary instru-

a *b*

ments showing them as at *a*, but a first-rate one more as at *b*. However, they are good for most practical purposes, and the last achromatic sufficient for almost all scientific purposes.

A few rules, however, from Wollaston, Brewster, and others might be interesting. The distance of the two lenses should be the difference of the two foci, *making a proper allowance for the thickness*. Here, again, is a vague direction. But it is, perhaps, explained by another direction.

The difference of the two foci must be greater than the thickness of the anterior lens. This rule being observed, the proportion of the respective foci is *ad libitum*.

Pritchard gives the following useful observations for doublets:—The convex side must be truly spherical. The distance of the two glasses to be got *by trial*; when got, to be left. Mount so as to be able to vary distance at pleasure, and to be able to turn lenses round, so as to centre them. He adds, I have spent whole days in readjusting two lenses which had been separated. A stop or diaphragm immediately behind the anterior lens supersedes any other. I find the field view to depend on the plane of the stop. When it is close behind the anterior lens no other is required.

The Tube.—There is generally, however, a stop, about one-third up the large outside tube, about eleven-sixteenths or fifteen-sixteenths diameter.

The Stand is a most important part of the compound microscope. It must be steady, and firmly constructed, and heavy. Take the lid of a common tooth-powder box, about three inches diameter; fix two uprights, about two inches high and one inch apart, in the upper part of it; into the hollow pour melted lead, to keep it firm and steady when you cannot use a clamp. On the under side glue three flat, even, round bits of wood as feet, to make it stand more evenly, but not more than one-eighth of an inch thick, two inches round, about two and a-half inches apart, one in the centre behind.

so well that I have much pleasure in recommending others to avail themselves of the same source. They will find at any respectable establishment everything they can want in the various departments of practical science, for the construction of home-made apparatus.

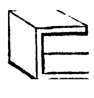
Prepare a nice bit of board, about seven inches long, one inch wide, and half an inch thick, and place it between the uprights, and mark the places for the entry of a screw on either side through the centre of the uprights, leaving the piece of wood just room enough to swing freely between the uprights without touching the pedestal.

About a quarter of an inch up it, and *precisely* central, make a round hole for a mirror frame. One and a-half inch above this again make two mortice holes perfectly straight, and in them fix with mortices (also perfectly in a right line) a small piece of board, two and a-half by two and a-quarter inches, leaving the quarter for the mortices. With a centre-bit make a hole of about three-quarters of an inch in diameter, in the exact middle of the boards.

Take a small piece of plate brass, about two and a-half inches long, and five-eighths wide, bend it across the stage so as to hold at the two extremes and yet to slide. Notch the part equal to the width of the stage about one sixteenth of an inch, and turn it neatly and squarely up, nipping off the two little bits which are left at the two ends which

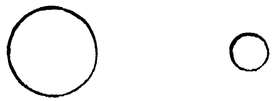
slide at the side of the stage. This will make a slide to keep the glass slips in their place, preventing them from slipping down when the instrument is sloped.

Bend another piece under the stage with its end wrapping over upward, and a little



way on the stage to keep it to it. This is to hold a piece of card with smaller holes in it than that in the stage. Make that in the stage to exclude light when required.

On the top of the moveable piece of wood and stem, fix a small block of wood slightly hollowed down the outer edge, about five-eighths of an inch thick, two inches long, and of such a width that a tube fixed against it shall have its centre exactly central to the hole in the stage and the mirror.

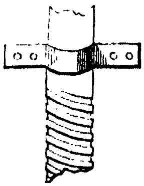


Now place the block against the stem, and place its one end even with the upper end of the stem. Mark two spots on the stem centrally, and draw two lines on the block even with them, and with these dots on the stem for the top of each; cut two *oblong slits* about a quarter of an inch long downwards, replace the block, and, with an instrument, at the top of each slit make a hole for a screw in the block.

Now with two rings, through which it might pass, or by gluing, fix on the incurved edge of the block a piece of tubing exactly its length, in which your whole telescope will slide tightly but smoothly; and, having done this, apply the block and screw into the holes already made, and through the slits in the stem, two eyelet-holed screws, till they hold the block

tight to the stem. Now get a round-headed screw which screws well in the eyelet-holes, about two inches long, and file a notch perfectly round it, just above the thread of the

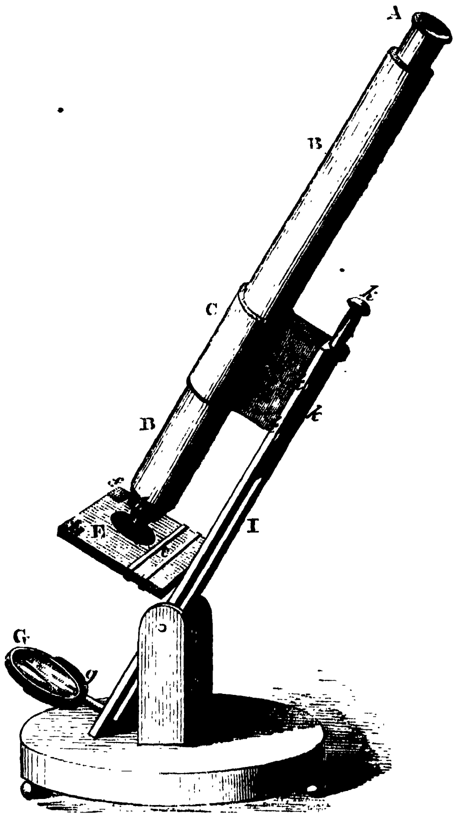
screw. Screw it into the two eyelet-holes of the screw, and then fix a piece of brass above, part of which goes into the nick round the screw and prevents its movement up or down. This screw will move the whole block up or down for nearly a quarter



of an inch, and, seeing that not a sixteenth is ever wanted, is perfectly sufficient for the fine movement or adjustment. Now put the whole together, and procure a penny looking-glass out of a doll's house, or one a little larger off a penny box at the German fair, or a ninepenny reflector, or a 2*s*., or 3*s*. from an optician's, and fix it in a fork frame thus, and the instrument is made :

You may cover it with paper. Plain gold paper is ninepence a sheet, and will cover six or seven. When not using cover the eyepiece with a pill-box, or take out both eye and object and keep them in match-boxes, to keep them from dust. You might put the whole instrument into a cigar-box, which you might procure for threepence at any tobacconist's. When thus mounted it will look as in the following figure.

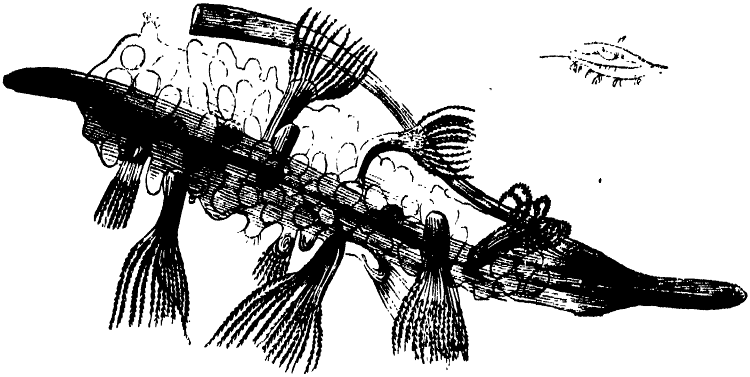
The use is as follows :—Place the object on its glass on the stage E, against the brass slide *e*, then gently adjust the large tube by sliding it near to the object, having first screwed the fine adjustment to the middle of the slits in the stem. Having gained nearly the focus, *i.e.*, the clear vision of the object, screw a very little (perhaps half a turn) the fine adjustment screw, looking in the instrument at the same time. When the object becomes perfectly clear and bright (the mirror of course having been adjusted



A, the eyepiece; B, the tube; C, holder for tube; *d*, object glass; E, stage; *e*, brass slide on upper part of stage; *f*, brass slide for holding pasteboard under stage; G *g*, mirror and frame; I, stem or support; K *k*, fine adjustment.

to show a good field) the arrangement is perfect. The field should be of a bright silvery ground-glass look, and the object on it clearly and brightly defined.

JAMES A. DAVIES.



Cycloum papillosum, natural size and magnified.

MINUTE LIFE OF THE SEA.

No physical object produces profounder emotions than the sea. When its broad expanse stretches far away from man and his habitations, and mingles with the gray transparent tints of the distant atmosphere, a sense of the Infinite instinctively pervades the human breast; the mind treasures up so apt a symbol of its future destiny, and long after the world of water and its coasts have been exchanged for other scenes, their image reappears in contemplative hours, when

> "Our souls have sight of that immortal sea
> Which brought us hither,
> Can in a moment travel thither,
> And see the children sport upon the shore,
> And hear the mighty waters rolling ever more."

The tides and storms also furnish us with the most striking illustrations of immense, but regulated power. Viewed under one aspect, nothing seems so changeable as the sea; surveyed under another, it becomes the image of the permanence of Nature, the stability that results from incessant, but accurately compensated motions, and we feel the truth of Byron's exclamation,

> "Time writes no wrinkles on thy azure brow,
> Such as creation's dawn beheld,
> Thou rollest now!"

But it is not alone the great things of the sea that demand our admiration, for its minute forms of life make an equal appeal to our faculties of wonder and delight. Taken as a whole, the minute life of the sea offers a more fascinating study than the minute life of land or fresh-water, and it enlarges our ideas. How poor, for example, would be our notion of polyps and their works, if we only knew the common aquatic sorts, and had not seen the associated groups that construct the elegant shrubs and trees of the Sertularia, and whose near relations build up their hundred miles of coral reef. How incomplete and derogatory to their order would be our conception of the family of worms, if we thought only of the unpleasant-looking creature that wriggles through our garden mould, and had not caught sight of his marine cousins, whose elegant forms and glittering colours amply justify the naturalists who bestowed upon them the names of sea-nymphs and goddesses, whose beauty was the theme of the Greek poet's praise; nor could we, if unacquainted with salt-water life, form an adequate idea of the amazing variety of shape, organization, and

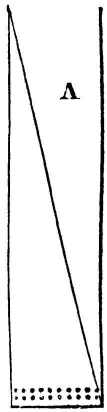
development that enters into creation's plan, and makes the kingdom of zoology a harmonious mosaic, so beautiful that all must reverently admire; so complicated, that none can fully understand.

The seaside naturalist has many ways of obtaining the specimens that will lead him to these conclusions. He may sweep the smooth bottom of a sheltered bay with a dredge, or tear up masses of growing weed with grappling hooks, called a "drag," or he may skim the surface with a muslin net, or employ the same implement to gather anything that may be swimming at a moderate depth; but these plans, although indispensable for particular purposes, are not always available to the casual visitor, and it is fortunate that a great many curious objects may be collected without their aid. This we shall proceed to show, by describing a portion of our own captures, during a three weeks' sojourn at Lyme-Regis, a charming little watering-place, but by no means one of the best spots for the marine zoologist to pursue his work. The weather, although fine, was usually too squally for boating, and when the local wind dropped, a heavy ground swell rolled in, and told its story of a distant storm. Occasionally we were tempted to trust the treacherous waves, but some friendly seagulls came close to our windows, and squeaked like a litter of young puppies, which was their mode of informing us that gusty weather was at hand. We had therefore to content ourselves with rambles along the beach, our favourite way being towards the pretty village of Charmouth, where the east and west lines of cliff dip their strata, and leave an open space. A few yards from a dingy cottage, apparently worth about ten pounds a year, and dignified by the name of the "Town Hall" of Lyme-Regis, a little path turns to the right, by the side of a house, and leads to a grassy hill that rises above the beach, and commands a magnificent view of the eastern side of West Bay. The lias cliffs with their remarkable alternations of bands of hard bluish limestone, and their beds of black shale, make a graceful sweep towards Charmouth, and beyond it the yellow sand on the lofty and square summit of "Golden Cap," glistens in the sun, while in the distance the mountainous mass of Portland stands out distinctly, but soft and shadowy as a cloud. Descending towards the beach, and scrambling over a small stone breakwater, the visitor finds himself, if the tide has receded, on a large field of flat rocks chiefly covered with bladder weed, and which in old times, when kelp-burning was in fashion, produced the corporation a revenue of considerable amount. Numerous workmen, in picturesque blue smocks, are busy quarrying out limestone, which is valuable for hydraulic cements, and as they continually discover some fragment of the ancient world, you are invited to buy a tooth or vertebra of an ichthyosaurus, a fin-spine of a fossil shark, an entire fish of a preadamite species, a characteristic ammonite, or a fragment of the beautiful stone-lily (*Pentacrinite*) for which the formation is celebrated.

Much might be said upon these matters, but we are off to the pools among the rocks, or busy with hammer and chisel detaching small zoophytes from the under side of ledges, that you must go down on your hands and knees to get at. Every pool is not equally promising; but here is one where broad thin leaves of pale brilliant green contrast prettily with a margin of red, violet, and purple, formed by tufts of the common coralline, which, on closer examination, is observed to be composed of branching threads about the thickness of twine, and covered with carbonate of lime. Shrimp-like creatures dash through the clear water, or dodge in and out among the maze of red and brown plants which add their variety of form and colour to the miniature scene, and here and there a large stone stands like a little mountain, overshadowing

the tiny lake. Here we are certain of obtaining a variety of interesting things. We pluck a few of the corallines and place them in a wide-mouthed bottle, together with a handful of the brown and red weed. We turn the big stone upside down—a few anemonies are attached to the hollow under surface; some small worms are captured before any can wriggle away, and in a little hole we descry an exquisite star-fish (*Ophiocome neglecta*), with six delicate arms that look like bristling centipedes, attached to a small central disk. Arms and all, he is not bigger than a shilling, and has nearly succeeded in hiding himself, when he is luckily caught and bottled, before he has time to break himself in pieces by way of showing his spite.

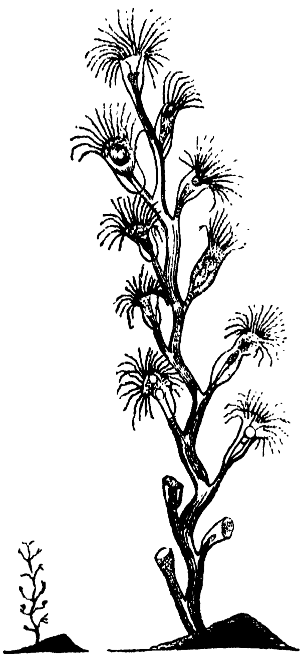
In a little while we have pretty well filled a common pickle-bottle, and hasten home to see the result of the morning's work. The first thing is to transfer the whole lot to a washhand basin, which makes an extempore aquarium, and then we quietly look over the contents. The chips of stone from the rock ledge exhibit a few sponges, some white stuff, like ribbons of tough blanc-mange, which is recognized as the spawn of the doris, and some little trees not thicker than sewing thread. These last are put carefully into a small wide-mouthed bottle, with sea-water; being obviously compound polyps, they are left to make themselves comfortable while the microscope is got ready. Objects of this kind are best observed in a glass vessel, furnished by opticians, and called a "zoophyte trough." It is composed of strips of plate-glass, cemented together with marine glue. A convenient size is two and a half inches wide, two inches high, and about three-eighths of an inch from the front to the back, internal measurement. Such a glass will stand upright without support, which is a great convenience, while by a simple, ingenious contrivance, any object may be brought as close to the front as may be desired. This is effected by means of a false back and false bottom of plate-glass, the arrangement of which will be obvious from the accompanying section of the trough, in which the dotted lines represent the false bottom, and the slanting line the false side.



Section of Zoophyte Trough; the slanting line represents the false back, and the dotted lines the false bottom, which keeps the former in its place.

Any object dropped into the space A falls till it is stopped by the front and false back; and the space A may be diminished to any extent required, by bringing the false back nearer a perpendicular position, and holding it at any angle by means of a wedge of cork inserted between it and the real back of the trough. Having arranged the trough as shown in the diagram, a few of the little zoophyte trees are placed in it, and examined with a low power and an oblique light. Very beautiful does the spectacle appear; the little tree rises perpendicularly from its mass of rock; the main stem is of a horny imperfectly transparent substance, and exhibits graceful curves alternating from right to left. From each angle of the zigzag a short branch springs, turned a little outwards, rather more transparent than the trunk, strengthened by horizontal rings, and terminating in a clear oval cell like a goblet of fine thin glass. In each cell lives a polyp, associated through the stem with the rest of the family, but enjoying all the advantages of individual life. When he desires repose he retires within his cup, and when actively inclined protrudes a bunch of tentacles, resembling in structure those of the common hydra described in a previous paper, but having the appearance of frosted glass. The number of tentacles does not seem constant in

the same species; those before us had as many as twenty-eight, and with a dark ground illumination they glistened like the pendants of a chandelier. At times they were as still as the petals of a flower, but the touch of any small object stimulated them to action, and the intruder, if appetizing, was rapidly transferred to the digestive cavity. When freely expanded they did not seem



Laomedea geniculata, natural size and magnified.

inconvenienced by a strong light, although they grow in a situation which could never have been more than feebly illuminated, and were more ready to come out if kept in the shade. The ordinary form of the mouth was bulbous, but the shape varied considerably according to the degree of expansion and the quantity of food they had managed to swallow. They were delicate creatures, and numbers of the community often died without any apparent reason, and those often exhibiting all the symptons of health. The decease of one polyp did not, however, affect the happiness of his neighbours, and a swarm of animalculæ assisted to dispose of his mortal remains.

The species we have been describing is the *Laomedea geniculata*, which, by means of a "creeping root," as Mr. Gosse calls it, sometimes spreads over a considerable surface, sending up the little trees in close proximity like a plantation or a forest. In addition to the polyp cells, they bear others containing a mass of embryos, which develop into tiny medusoids, like little umbrellas, with a fringe of numerous tentacles, and a club-shaped foot (peduncle), where the ferule of an umbrella is placed, and not *inside* the convexity, as is usually the case with real medusæ. Some of our specimens exhibited the germ cells apparently well filled, but none were hatched, so we must content ourselves with Mr. Gosse's account. At the moment of birth he found them languid, but they soon gained strength, and made their way rapidly through the water by "a sort of flapping motion of all the marginal threads together." He was never able to keep them long, and I am not aware that any other naturalist has been more successful. There is, therefore, some doubt as to what they really are, whether larval forms, which subsequently assume the parental shape, or whether, as he suggests in his "Devonshire Coast," they are "male polyps;" an idea which, if it should prove correct, would indicate a higher organization than these creatures have been supposed to possess. It should be mentioned that this species is not confined to rocks, but often found attached to the roots of the seaweed.

For the sake of brevity we have confined our remarks to the *Laomedea geniculata*, but other species and representatives of other genera of associated polyps were discovered either on the rocks or attached to seaweed. The structure, however, of the polyp family is essentially the same, and they may be

readily distinguished from the more highly-organized polyzoa by the character of the tentacles—those of the polyps being soft, warty, and extremely flexible, while the similar organs of the polyzoa are stiffer and smoother, except at two opposite edges that are thickly set with cilia, whose motion, apparently down one side and up the other, is very striking and conspicuous.

The polyzoa, like the polyps, are a numerous family. Our ponds and streams contain several fresh-water representatives, and they abound on rocks and seaweeds near the shore, so that our collection was very likely to contain some specimens. Some are in the habit of forming elegant incrustations upon flat weeds; others surround the stems of the coralline, or other marine plants that have smooth round branches; and others spread themselves over rocks. Here, perhaps, we have an example, not beautiful enough for love at first sight, but yet sufficiently odd-looking to provoke examination. It is merely a dirty white substance, like a bit of gristle, which surrounds a slender branch of the coralline for the length of about half an inch. With the help of a pocket lens it is observed to be covered with small blunt conical excrescences, but not a symptom of either cells or polypides can be descried. By leaving it, however, in the glass trough in a shady place, and with a comfortable allowance of water, in which plenty of infusoria were dancing about, it assumed a very different aspect.

From various parts of the mass, but not from the little projections, out came a bunch of long tentacles, having a transparent bag tied round the neck from which they sprung, and a central aperture through which their food was swallowed. The protruded portion of the bag was sufficiently transparent to enable the intestine to be seen throughout nearly all its course, and to exhibit its peculiarity of terminating near the mouth. The tentacles were darted in and out with great rapidity, and when equally expanded formed an elegant bell. They were of clear glassy texture, and exhibited the remarkable ciliary structure already described, the effect of which was to cause a series of whirlpools that affected large infusoria at a considerable distance. Often a single tentacle moved impatiently, like a beckoning finger, and if a living object adapted for food was carried towards the mouth, they all closed to assist its passage to destruction. The living prey was first conveyed to a crop or gullet, where it might be seen swimming about until a sudden spasmodic muscular contraction hurled it downwards to reappear no more.

The larger polyzoa display the details of their structure better than the Cycloum, but one principle of construction pervades them all, and we shall obtain an idea of it by conceiving of a tube bent like a U, one termination being the mouth and the other the vent. This tube is inclosed in a bag, the upper part of which is, so to speak, tied round the neck just below the mouth, leaving the tentacles free. When the animal retreats into its cell, a process which is technically called *invagination* takes place; that is, the mouth of the bag is turned inward, carrying with it the tentacular crown. Near the mouth is situated a cerebral ganglion or brain, and the muscles by which the chief movements are effected possess a very high organization, having *striated fibre*, which is the characteristic of those muscles which are under the control of volition in the higher animals, or in man. This has not been observed in all species, but it is probably a common property, and we have seen it well displayed in the *Plumatella repens*, which inhabits ponds or streams. Another peculiarity of their muscles is, that in their natural state they exhibit the ultimate fibrils of which they are composed, which those of higher animals only do after skilful anatomical preparation.

Each polypide, or polyzoon, is moored to his cell by a living rope (*funiculus*); to which

are attached the generative organs. They multiply by eggs, by the growth of fresh cells from the parent mass, and in many species by *statoblasts*—as Professor Alman calls them—or a kind of egg which partakes of the nature of a bud, and remains undeveloped for an indefinite time. Many of the marine species are furnished with appendages that have given rise to so much discussion, the so-called "birds' heads." The most striking form of these organs is that of a vulture's head; but in the sea-mat (*Flustra foliacea*), which is often picked up on the shore, they are more like little rounded boxes with lids moving on a hinge. Whatever shape they possess their action is the same, opening and shutting as if to snap up some prey. If they ever catch anything, they have no known way of transferring it to the mouth or digestive cavity; and Mr. Gosse has suggested that they may possibly hold small animals till they die and attract a swarm of animalcules, which the ciliary currents of the tentacles may cause to be swallowed up. The conjecture is ingenious, but doubtful; and if such be their function, we should expect to find them very often in the act of discharging it. The presence of these organs is made a ground of classification; but Dr. Harvey remarks that their appearance is not always constant in the same species, and hence their value is lessened for purposes of identification.

Although we cannot at present enter into descriptions of the remaining animals in our collection, we may observe that it contained several nerrids and other worms, several small crustaceans, five or six zoophytes, and three or four polyzoa, to say nothing of rotifers and infusorial forms, one of the latter resembling the Vaginicola, described in vol. ii. p. 116, except that, instead of a wreath of cilia, it had a few of a stiffer (more spine-like) character, and bifurcated or forked.

The singular spawn of the doris was kept for some weeks, but instead of developing, the ova gradually decomposed. An examination, with a power of from sixty to a hundred linear, displayed the structure of the curious mass, and exhibited parallel rows of white ova embedded in a clear, transparent jelly. Each young doris occupied an exceedingly delicate nautilus-shaped shell, which was continually moving under the influence of two ciliated organs, like the wheels of a common rotifer or the paddles of a steamer.

These seaside objects are well worthy of study by our manufacturers. What an elegant pattern for a dress or a drawing-room paper might be made from the *Laomedea*, giving a pleasant brown tint to the stem, and rendering the cups and tentacles in silver or silver-gray.

HENRY J. SLACK, F.G.S.

GREEN PEAS AND THEIR PODS UNDER THE MICROSCOPE.

"WELL, I wonder what they would look like!" is perhaps the first exclamation of the reader on seeing the above title, supposing him to be a beginner, with one of these charming instruments, wanting really to work for himself. And straightway he may be imagined as going to fetch a fine pod, putting it on the stage bodily, and then in disappointment exclaiming that "nothing is to be seen but a confused green mass." Even the binocular, which is to show so much "just as it is," without any kind of preparation, would fail to reveal anything more in such a case as the present. We must get out a few slides and some thin glass covers, a tumbler of clean water, and a razor, and our apparatus will be

complete. No, stay—a wine-bottle cork, and a piece of string in addition, must be got out for some of our sections, and it will be as well to have a bottle of glycerine, and some varnish composed of equal parts of asphalte and japanner's gold-size; with these we shall be able, with very little expenditure of time or trouble, to preserve our sections for any length of time.

Although, in the natural course of things, the consideration of the capsule should perhaps precede that of its inclosure, there will here be some advantage in reversing this order of procedure, so let us take out a pea and set to work. It should be a fully grown pea, and will be all the better if ripened beyond its primest condition for the table. Now with the razor (which should be very sharp) and, holding the pea firmly between the thumb and finger of the left hand, take off almost the thinnest shaving you can manage, and lay it on a slide with a drop of water, then try two or three more. By this time the cotyledons or seed-leaves, will have been reached. When a pea sprouts these are the first parts that appear; the cells composing them are densely filled with starch, which serves as nutriment for the young plant till its tiny first leaves and roots are sufficiently formed to draw for themselves, from the heavens and the earth, the materials of life. It will be best now to take off a good thick section from our pea, nearly half way through; then one or two, very carefully, as thin as possible; and, putting a cover on, let us see what awaits us.

The first coat (Fig. 1, B) is composed of rounded cells with very thick walls; each has an irregular cavity, which, in looking through it, appears quite dark; from this cavity fine lines radiate in every direction, which permit, to a certain extent, of the passage of fluids. Those to whom the structure of bone is familiar, will at once recognize the analogy between the parts just described with those to which, in bone, the names "lacunæ" and "canaliculi" are applied. They are the same structures, and, in the hard parts of some seeds, the resemblance is so close that it is not always at a first glance easy to say whether the

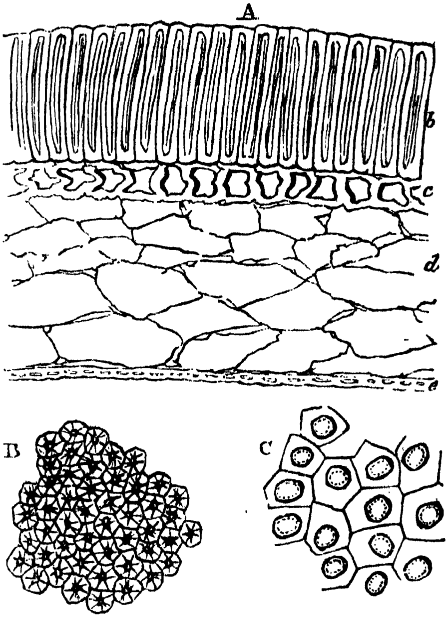


Fig. 1.—A, transverse section through a pea; B, cells forming the first, C, the second, and E, the third coat; D, loose cellular tissue. The small letters denote the same parts in the section. Magnified 200 diameters.

object examined be animal bone or vegetable bone. The most bone-like occur in the stones of plums, in the hard and brittle outside of fig-seeds, or the outer coat of hemp-seed, which uncommonly resembles true bone. In

order to tell which it is, look for the outlines of the cell walls; if found, these at once say "I am not animal bone."

The second coat (Fig. 1, c) looks at first like a number of dark rings, the central vacuities in cells, of which the square or slightly hexagonal outlines are so delicately marked as to require careful looking for if you would see them.

We now find a loose mesh of hexagonal lines, indicating thin dried-up cells, that, theoretically, do not form a proper seed-coat at all; but merely a means of connecting the second and third coats (Fig. 1, E). The latter is formed of fine cells, rather long in proportion to their width, which envelope the starch-cells forming the substance of the seed, so closely as to be scarcely separable. These are arranged in such manner that their long axes incline in various directions to all points of the compass.

The value of the transverse section (Fig. 2, A) will appear on now turning to it; the relative thickness of the various tissues forming the seed-coat is readily seen, and ideas can be formed of the mechanical importance of the structures entering into it. In the present instance the outer, *b*, is seen to be four times as thick as the middle and inner ones combined, putting out of the calculation the loose irregular connective tissue, *d*, which, though in theory it be *nil*, no doubt has some purpose of its own to fulfil. If the section be examined first without the addition of water, and then a little added whilst the observation is being made, it will be seen to swell up enormously, so as to become one of the most noticeable features in the section, though previously it could not be seen at all. Is it too much to suppose that it acts the part of a sponge, imbibing the water which serves as the appropriate stimulant to the first growth, through the strong affinity for that fluid possessed by a gummy or mucilaginous material contained in the cells? We know how greatly and how rapidly a pea or bean increases in size during the first stages of germination, and that from being as hard as a bullet it quickly becomes soft and pulpy.

Now take one-half of the pea-pod, nick it slightly, and tear up as much of the thin membrane on the outside as will come away, and put it on another slide with water. A thin shaving of the central pulpy part of the pod is easily made, and should be put with the latter. Then scrape away slightly but firmly all the pulpy part, and a dry-looking, fibrous membrane is reached, which, even to the naked eye, looks somewhat glistening. This is principally composed of the woody coat; it has very firmly adherent to it two thin membranes, one on its outer, another on its inner side, the outer of which can hardly be removed in any but a shreddy, unsatisfactory way for separate examination. The cork should now be cut about half way down its middle, a piece of the pod in good plump condition be put into the slit and firmly tied; then, with two or three trials, a fine thin even section will be obtained.

The first thin skin removed from the pod is the cuticle (Fig. 2, B), the cells of which are narrow and slightly pitted; numerous stomata or breathing apertures, marked *s s*, will be seen on it: these are openings for the admission of air into the interior, closed more or less by a pair of kidney-shaped cells. As a plant has no power of voluntary motion, we may imagine its delight as its leaves are "kissed by the whispering breeze;" and though the leaf is not the subject of our present meditation, yet the pod is only a pair of leaves modified to suit a special purpose.

The second coat, the 'pulp' (Fig. 2, C), is composed of rounded cells, somewhat smaller towards the outer part, and there filled chiefly with green colouring matter. Most of the cells, however, contain starch, which increases in quantity with the advance of maturity. The microscope thus shows us that in throwing away the "pea-swads," as unthrifty house-

wifes contemptuously term them, a large quantity of nutritious matter is cast away, which, by good cooks, is made into one of

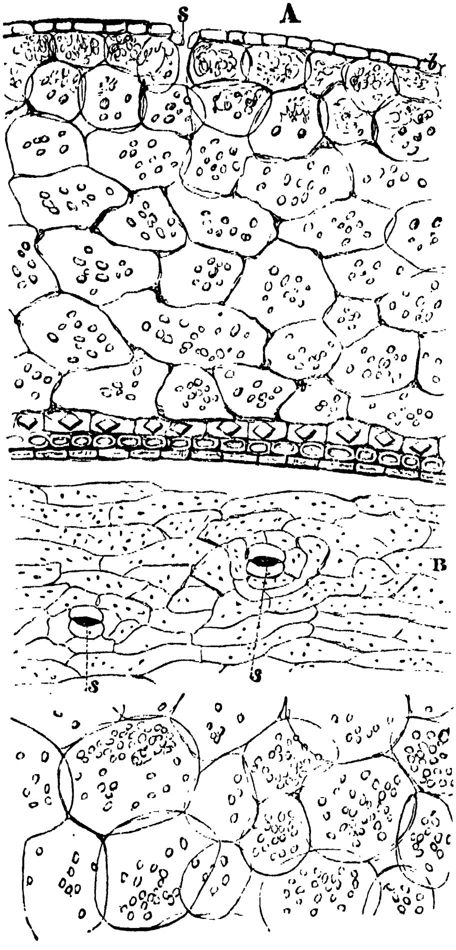


FIG. 2.—A, transverse section through pea-pod; B, first layer or cuticle with its stomata; C, large rounded cells of the pulpy part with starch.

the greatest delicacies of the table, "Green-pea Soup."

Proceeding further inward in our examination, we find a layer of square or somewhat hexagonal cells (Fig. 3, D), containing very fine raphides, one in each, and occasionally two will be found in a single cell.

The strong woody coat (Fig. 3, E) next claims attention. The cells composing this are

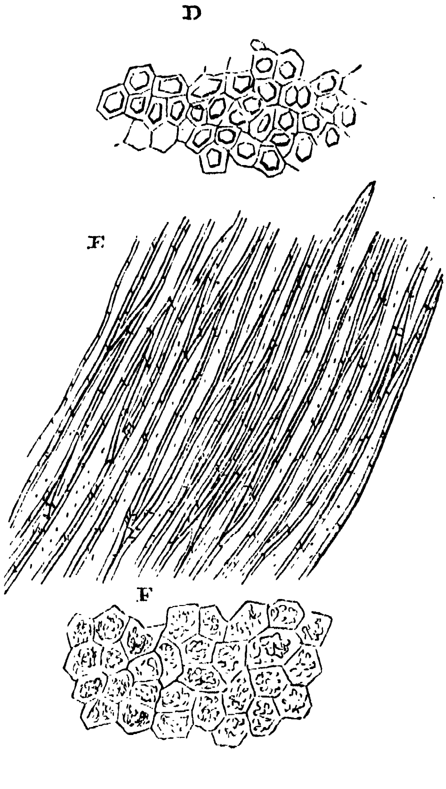


FIG. 3.—D, cells containing large raphides; E, woody coat; F, delicate cells with bright green contents. Magnified 100 diameters.

long, spindle-shaped, very tough, pitted, and inclined, at an angle of 45°, to the long axis of the pod. They furnish a good example of true "prosenchyma," as this form of tissue is technically termed.

Lining the latter, and situated most inwardly, is a delicate cuticle (Fig. 3, F), formed of hexagonal cells with green contents. To this latter coat I am disposed to attribute somewhat remarkable hygrometric proper-

ties. When a pod is quite ripe the valves, rending the thin membrane by which they are united, curl inwards suddenly and powerfully, and, by that means, the seeds are scattered to a distance. Now I find that when the pulpy part, C, is removed, this inner cuticle, F, dries rapidly, thereby contracting (in all probability) very much, by this means drawing inwards the fibrous membrane, E, and producing the effects just named.

As it is advantageous to preserve for future examination and comparison objects on which time has been bestowed, a drop of glycerine may be put at one side of each thin covering glass; with the evaporation of the water added at first, this will be drawn into our specimens by capillary attraction, and then, by applying a little of the varnish round the edges, a permanent and valuable specimen will have been obtained. A few such, made by one's self, are really far more instructive than a greater number purchased ready to hand. Besides which it is interesting to know the structure of the "common objects" by which we are surrounded in our daily life, in which the same grand laws may be discovered as make of the world we inhabit, and all the objects it contains, with the countless spheres to be discerned from it in the firmament, one grand harmonious whole, hymning His praise

> "Who planned and formed and still upholds a world,
> So clothed with beauty for rebellious man."

TUFFEN WEST, F.L.S.

ASTRONOMICAL OBSERVATIONS FOR JULY, 1861.

THE Sun is in the constellation of Cancer until the 22nd, and then in that of Leo. He rises in London on the 1st at 3h. 49m., on the 10th at 3h. 56m., on the 20th at 4h. 8m., and on the 31st at 4h. 23m.; setting on the 1st at 8h. 18m., on the 10th at 8h. 13m., on the 20th at 8h. 3m., and on the 30th at 7h. 49m. He is above the horizon in London on the 1st, 16h. 29m., and on the 31st, 15h. 25m.

The Sun rises at Edinburgh on the 11th at 3h. 32m., on the 21st at 3h. 46m., and on the 29th at 4h. 1m.; setting on the 17th at 8h. 31m.; and on the 30th at 8h. 7m.

He rises at Dublin on the 1st at 3h. 38m., and on the 29th at 4h. 14m.; setting on the 4th at 8h. 27m., and on the 30th at 7h. 57m.

Day breaks in London on the 30th at 1h. 21m.

Twilight ends in London on the 26th at 11h. 17m.

Length of day at Edinburgh on the 14th, 16h. 57m., and on the 30th, 16h. 3m.

Length of day at Dublin on the 16th, 16h. 24m., and on the 31st, 15h. 38m.

The Sun is on the meridian on the 1st at 12h. 3m. 29s.; on the 15th at 12h. 5m. 38s., and on the 30th at 12h. 6m. 7s.

The equation of time is on the 1st, 3m. 29s., on the 15th, 5m. 38s., and on the 30th, 6m. 7s. subtractive (or after the Sun).

The Sun is farthest removed from the earth on the 3rd, and there is a solar eclipse on the 8th, invisible in England, but visible in Sumatra, New Guinea, part of Australia, and the South Pacific Ocean.

The Moon is new on the 8th at 2h. 12m. a.m.

Full Moon on the 21st at 12h. 5m. a.m.

She is at her greatest distance from the earth on the 1st, and again on the 29th, being at her least distance on the 16th.

Mercury is in Cancer, and at the commencement of the month favourably situated for observation. He is an evening star until the 22nd, when he becomes a morning star. He rises on the 5th at 6h. 2m. a.m., and on the 30th at 3h. 42m. a.m.; setting on the 5th at 9h. 10m. p.m., and on the 30th at 6h. 48m. p.m. His diameter on the 1st is 8½s., and the 25th, 10½s.

Venus is in Gemini at the commencement of the month; passing through Cancer to Leo, where she is at the close of the month. She is unconspicuous from her vicinity to the Sun. Her diameter is on the 1st, 10s., and on the 25th, 10½s. She rises on the 5th at 5h. 6m. a.m., and on the 30th at 6h. 23m. a.m.; setting on the 5th at 9h. 12m. p.m., and on the 30th at 8h. 45m. p.m.

Mars is in Cancer at the commencement of the month, and in Leo at its close. He is very unfavourably situated for observation, and scarcely visible. His diameter not 3½s. He rises on the 5th at 5h. 17m. a.m., and on the 30th at 5h. 9m. a.m.; setting on the 5th at 9h. 19m. p.m., and on the 30th at 8h. 19m. p.m.

Jupiter is in Leo throughout the month. He will be close to the star Regulus on the night of the 21st. He is favourably situated for observation, and his diameter is on the 1st, 30¾s., and on the 25th, 29½s. He rises on the 5th at 7h. 44m. a.m., and on the 30th at 6h. 35m. a.m.; setting on the 5th at 10h. 16m. p.m., and on the 30th at 8h. 47m. p.m.

Saturn is in Leo, and a conspicuous object. He rises on the 5th at 8h. 39m. a.m., and on the 30th at 7h. 15m. a.m.; setting on the 5th at 10h. 39m. p.m., and on the 30th at 9h. 5m. p.m.

Uranus is in Taurus, and a morning star. He rises on the 5th at 1h. 48m. a.m., and on the 30th at

12h. 14m. a.m.; setting on the 5th at 6h. 6m. p.m., and on the 30th at 4h. 34m. p.m.

Occultation of Stars by the Moon.—On the 25th κ Piscium (4½ magnitude) disappears at 12h. 42m. a.m.

Eclipses of Jupiter's Satellites.—Owing to the nearness of Jupiter to the Sun, no eclipses are observable throughout the month.

Stars on the Meridian.—On the 1st, Antares souths at 9h. 41m. 17s. p.m. On the 4th, α Herculis souths at 10h. 17m. 46s. p.m. On the 5th, α Ophiuchi souths at 10h. 32m. 57s. p.m. On the 5th, α Aquilæ souths at 12 h. 52m. 2s. a.m. On the 8th, α Ophiuchi souths at 10h. 22m. 10s. p.m. On the 11th, α Ophiuchi souths at 10h. 9m. 22s. p.m. On the 13th, α Lyræ souths at 11h. 5m. 4s. p.m. On the 16th, β Lyræ souths at 11h. 5m. 57s. p.m. On the 18th, δ Aquilæ souths at 11h. 31m. 33s. p.m. On the 20th, α Ophiuchi souths at 9h. 33m. 59s. p.m. On the 23rd, γ Aquilæ souths at 11h. 32m. 59s. p.m. On the 24th, α Aquilæ souths at 11h. 33m. 24s. p.m. On the 25th, α Aquilæ souths at 11h. 29m. 28s. p.m. On the 27th, β Aquilæ souths at 11h. 26m. 5s. p.m. On the 29th, α Capricorni souths at 11h. 40m. 1s. p.m. On the 30th, α Ophiuchi souths at 8h. 54m. 40s. p.m. On the 30th, α Aquilæ souths at 11h. 10m. 25s. p.m. On the 31st, α Cygni souths at 11h. 58m. 25s. p.m.

The variable star Algol reaches its minimum light during the evening, July 23, at 9h. 54m.

E. J. Lowe.

METEOROLOGY OF JULY.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

—o—

Year.	Mean Temperature of the Air. Degrees.	Mean Temperature of the Dew Point. Degrees.	Mean Pressure of the Air. Inches.	Mean Amount of Cloud. (0·10).	Number of Rainy Days.
1846	68·4	—	29·764	6·1	16
1847	67·8	60·0	29·854	5·2	7
1848	61·5	54·4	29·808	6·9	20
1849	59·8	53·4	29·795	6·4	17
1850	60·2	55·6	29·819	7·5	21
1851	58·6	52·4	29·723	7·3	19
1852	66·8	60·5	29·877	5·8	8
1853	59·1	48·8	29·690	8·2	19
1854	59·4	53·3	29·785	7·7	19
1855	60·0	55·4	29·720	7·9	13
1856	59·4	52·2	29·781	6·8	14
1857	61·3	55·0	29·854	7·1	16
1858	60·6	48·6	29·758	6·4	11
1859	65·2	58·0	29·921	6·5	9
1860	58·6	50·5	29·819	7·6	13
Mean	61·8	54·2	29·798	6·9	15

The mean temperature of the air of the last fifteen years, for July, is 61·8°, the range in the mean temperature being from 58·6° in 1851 and 1860 to 68·4° in 1846—a difference of 9·8°. The lowest means occurred in 1849, 1851, 1853, 1854, 1856, and 1860, and the highest in 1846, 1847, 1852, and 1859.

The mean temperature for July, of the last fifty years, is 61·3°, and it was as high as 68·4° in 1846, and as low as 55·5° in 1841, giving a range of 12·9°. The next hottest year was 1847, viz., 67·8°, and the next coldest, 1816 and 1817, viz., 57·8°.

The mean temperature of the dew-point for the last fourteen years, for July, is 54·2°, the range being from 48·6° in 1858 and 60·5° in 1852—a difference of 11·9°. The lowest means occurred in 1853, 1858, and 1860, and the highest in 1847, 1852, and 1859. In 1858 the temperature of the dew-point was 12·0° below that of the temperature of the air, and in 1853, 10·3° below, whilst in 1850 and 1855 it was only 4·6°, and in 1857, 5·4°.

The mean pressure of the last fifteen years, for July, is 29·798 inches at the height of 174 feet above the mean sea-level, ranging between 29·690 inches in 1853, and 29·921 inches in 1859—a difference of 0·231 of an inch (less than a quarter of an inch). To reduce these readings to the mean sea-level, it is requisite to add 0·185 of an inch, when the mean temperature is as low as 58·6°, as in 1851 and 1860; and 0·181 of an inch when it is as high as 68·4°, as in 1846. On applying this correction, the mean pressure of the last fifteen years, for July, when reduced to the sea-level, is 29·980 inches.

The mean amount of cloud, for July, of the past fifteen years is 6·9 (or under seven-tenths of the whole sky); the amount being as much as 8·2 in 1853, and as little as 5·2 in 1847—a difference of three-tenths of the whole sky.

The mean number of rainy days, for July, of the past fifteen years is 15, ranging between 7 in 1847, and 21 in 1850—a difference of 14 days (or three times the number). The years of but little rain are 1847, 1852, 1858, and 1859; and of much rain 1848, 1850, 1851, 1853, and 1854.

July is usually the hottest month of the year, and subject to violent thunder-storms.

E. J. Lowe.

THE MICROSCOPIC OBSERVER. JULY.

Pond Gatherings.—Standing waters and running streams afford very different classes of objects, and there is one certainty at this time of year that whether the products obtained be rare or common, they are sure to be plentiful. A small muslin net attached to a walking-stick, and a few phials are all the apparatus needed for at least a beginning in pond lore, and by reference to the various articles by Mr. West, Mr. Slack, and other writers in this work, the fullest information may be obtained for advanced studies. It is best to preserve all gatherings, unless the search is specifically confined to certain definite objects. Many good subjects will be perceived at once, as, for in-

stance, the threads of confervæ, the nimble-moving hydrachna, the bilateral and bright green desmids. The sediment at the bottom of a phial of pond-water will generally present the best part of the collection, and, to make a first examination of it, the animalcule cage must be used, and the objects must be sought at first with a low power. Just now the microscopist in search of amœbas may pretty safely rely on obtaining specimens from ponds to which some portion of the drainage from a dunghill flows, or where cattle not only drink, but browse the aquatic herbage. The first sight of an amœba is not attractive, and the careless observer may easily pass it by for objects of more definite and active character. If there are signs of animation in certain shapeless masses, noticeable only for their utter indefiniteness, the observer may make a rude guess that amœbas have been captured, and his next task will be to determine if the supposition is correct. A creature pretty certain to be found in the very first dip from any pool is the vorticella, or bell-shaped animalcule, a good cluster of which forms a really beautiful object, the commonness of which in no way detracts from our enjoyment in viewing it. This plentifully diffused creature, however, may very readily escape detection on a first examination, for the timid creatures contract on the slightest alarm, and some little time must elapse of perfect quiet to induce them to expand and display their vibrating cilia. The mere recognition, however, is far from sufficient; the circulation of the currents of water through the body must be seen, and the apertures, by which ingress and egress of the current is effected patiently traced out. It is a pretty sight to see one detach itself from the stalk, and whirl itself to and fro in giddy motions through the water. Rotatoria are rarely difficult of determination when obtained in miscellaneous gatherings, though it may not be so easy to refer them to their several families. In very foul ditches a fine animalcule may be now found in plenty, namely, the *Paramœcium aurelia*. It may be compared to a purse, through the texture of which a few coins are visible. If a little indigo be added to the water, the coins acquire its blue colour, and upon this fact Ehrenberg founded his classification of *Polygastrica*, or many stomachs; though the spots so characteristic of the family are not now regarded as stomachs by microscopists. But by far the best portion of a pond or brook gathering will be in the surface film found in little bays and inlets away from the course of the current, where there is one, or generally diffused along the shore line in all still waters. The best way to secure a variety of specimens is to take separate portions of the film from different spots on separate pieces of muslin, previously wetted. Each piece is to be folded up, and placed in wide-mouthed bottles. On arriving home they are to be opened into jars of filtered rain-water, and the products will soon become detached for examination. In the purest waters only will be found examples of *Uvella*, *Astasia*, *Euglenia*, and *Volvocineæ*, for they are incapable of existing in decomposing liquids. *Astasia hæmatodes* and *Euglena sanguinea* give a blood-red colour to water. The sheltered margins of ponds frequently exhibit a dust-like stratum, chiefly composed of *Euglena chlorogonium*, *Pandorina*, and *Gonium*, all leading members of the *Phytozoa*. The green colour of stagnant waters is generally an indication that *Phytozoa* abound in them. Where the green tinge is general and uniform, the following may be looked for as components of it:—*Monas bicolor*, *Uvella bodo*, *Cryptomonas glauca*, *Gonium*, *Chlorogonium*, *Euglena viridis*, *Chlamydomonas*, *Pandorina*, *Volvox*, and *Stephanosphæra*. The last named sometimes occasions difficulty in selecting specimens in different stages of development. Mr. Cohn's method of operating obviates this. He half fills with water containing *Stephanosphæra*, a flat bottle with a short narrow neck. The cork is then inserted, and the bottle is laid on its side horizontally, so that the cork partly dips in the water. In a few hours the revolving spheres collect in thousands on the cork. The cork is then taken out, and a drop of the water from it submitted to examination.

Insects to be Sought for.—*Colymbetes vitreus*, and *Colymbetes ater*, in clear, quick, running streams. *Berosus globosus* in stagnant pools. *Corynetes violaceous* in old barns, stacks of dry timber, and among dry rubbish. *Prionus coriarius*, amongst old oaks and beeches. *Balaninus nucum*, on hazel bushes. *Acridia grisea*, *A. varia*, *A. bipunctatum*, on sand-hills and dry barren heaths. For the butterflies of the month, see "Things of the Season" in the first volume.

Mr. Noteworthy's Corner.

The Finest Spar in England is the flag-staff lately erected in Kew Gardens. It is a specimen of the Douglas Pine, and is twice as high as the highest trees that surround it. Its total length is 157 feet; cubical contents, 160 feet; total weight, complete, 4 tons 8 cwt. 2 qrs. It is fixed in a brick well, and 11 feet 6 inches are sunk below the level of the ground. The age of the tree which supplied the spar was about 200 years, and its total height 220 feet. For this handsome and appropriate gift to the royal gardens, the public are indebted to Mr. Stamp, of Rotherhithe.

Experiments with the Colour-top—Concentric Patterns.—I have been much interested in the experiments with the Chromatrope Colour-top, described in Recreative Science, vol. i. p. 89. I find that a heavy top, made of brass or wood, with lead poured into a groove near the rim, and having a hardened steel point, answers very well, and is very steady, and remains in one place. It should be spun on a plate or tray, and the best material is tape, full half an inch wide, and drawn tight through the hole, to start with. My object in writing is to describe a set of patterns not mentioned as yet, and which are, to my mind, far the prettiest, and altogether novel in their effects. Annexed are diagrams of three of them.

They have no string attached to them, and the hole in the centre should be only just large enough to let them drop easily over the spindle of the top. They soon rotate at the same speed as the top. With one

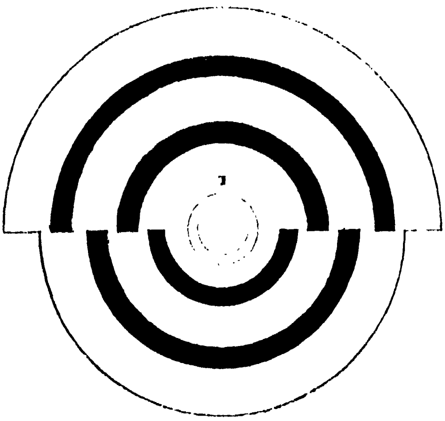


Fig. 1.

(Fig. 1) you see the most beautiful set of rings, and by touching the edge very gently with your finger, you can produce any colour you like in the rings. Of course you may have in the pattern more or fewer

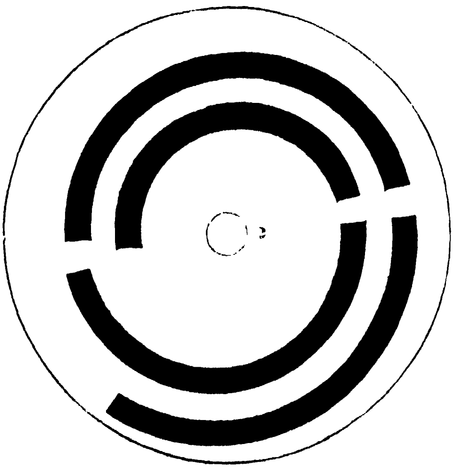
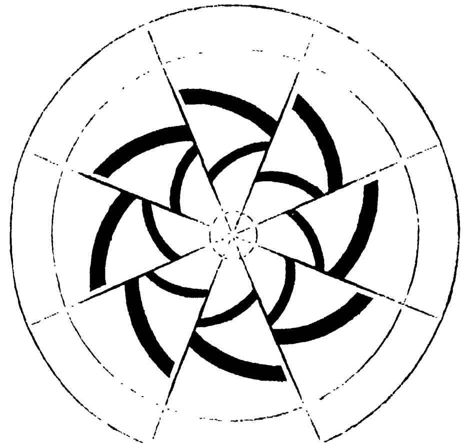


Fig. 2.

rings at pleasure. Fig. 2 is very beautiful, and must be treated in the same way as the last; it produces the most beautiful variation of rainbow colours imaginable. I subjoin also another pattern (Fig. 3), which requires to be impeded, which is best accomplished by means of wings, which are far better than string. Of course all are cut in cardboard, not very thick. In this last one the pattern should appear quite still, and the colours must be more subdued.



The hole in the centre should be about two to one of the spindle's diameter. It is, perhaps, then as pretty as any; but the first two show more the scientific nature of the top. In the centre of the impeded ones I always insert a slight ring of wood, to prevent their wearing, which, if jammed in, never moves from its place. It should not be more than one-eighth of an inch any way in thickness, and should have a shoulder for the cardboard to rest on.—W. A. Savorey.

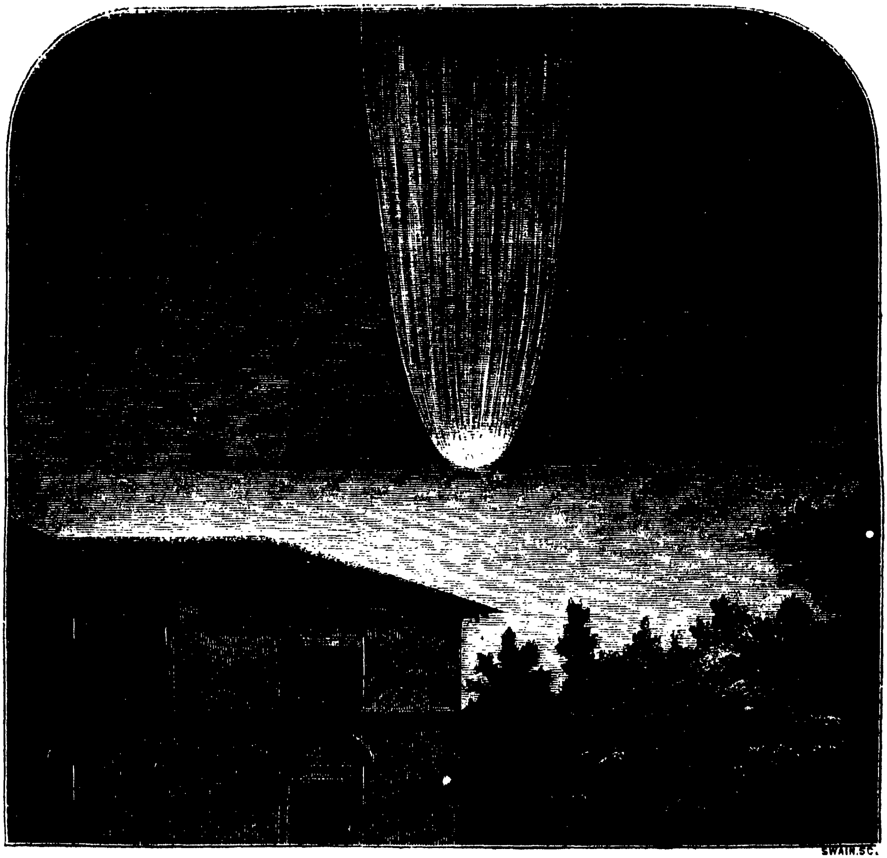
Suggestion to Geologists.—I have long wished for an opportunity of making the following suggestion, and perhaps can now do so through the medium of Recreative Science:—As in unity and method of labour more is always accomplished than in random, aimless working, could not all professional geologists work upon an organized system, could they not have the various geological formations alloted to them in the same manner as, among astronomers, the heavens are divided off to various observers? For example, the silurian to one, the carboniferous to another, and the oolite to a third; in this way each formation would be more thoroughly studied, and (if I may use the term) ransacked of its treasures. We should gain a greater knowledge of the nature of the rocks, and obtain more accurate information respecting the distribution of species among them. Until late years we remained in total ignorance of the fact that mammalia existed as low as the Stonesfield slate; it is only lately that fishes have been discovered in rocks as remote as the upper Silurian era, and many other similar facts. If each formation had its own student, and was diligently observed, these important facts would crowd in upon us, and we should advance with a quicker step to

more important conclusions, which we are now unable to deduce correctly for want of sufficient evidence; for facts must be multiplied on a subject before we begin to theorize. Perhaps it might be advisable for those geologists holding a high rank in the science to be the recipients of the facts collected by these observers, and generalize upon them. I cannot help thinking that an organized body of zealous labourers partaking of this character would meet with success worthy of its endeavours, such as has followed the same plan amongst astronomers.—Y. Y., *Bath, December*, 1860.

THE INFLUENCE OF TREES UPON TEMPERATURE.—M. Becquerel has lately read, before the French Academy of Sciences, a paper regarding the influence of trees upon the mean temperature of the atmosphere. From experiments, made with an ordinary thermometer and two electric thermometers in the Jardin des Plantes, he ascertained that 0° 63′ C. represents the heating of the air from the action of the sun's rays, 11° 53′ C. being the mean annual temperature ascertained by the electric thermometers, and 10° 90′ the mean temperature with an ordinary thermometer placed facing the north. One electric thermometer having been placed above a horse-chesnut tree, and the other in the middle of an open plain, it was ascertained that the mean temperature of the atmosphere above the tree, the thermometer being exposed to radiation from it, was only 0° 23′ C. above the temperature in the open space, and 0° 86′ above the temperature of the air as shown by a thermometer with a northern exposure. Comparing the observations made at different hours of the day, it was found that about 3 p.m., when the temperature is highest, the difference sometimes amounted to 2° or 3° in favour of the atmosphere above the tree, whilst at sunrise, after a clear night, the excess was on the other side, on account of the nocturnal radiation. This experiment proves the cooling of trees and the atmosphere surrounding them under the influence of nocturnal radiation. Vegetables near a wood are sooner affected by spring frosts and the cold of autumn than vegetables at a distance from them. Under the influence of solar radiation above the trees, there is a current of warm air ascending during the night, and in the morning a current of cold descends to cool the soil. When the sky is cloudy these differences of temperature are very small. These experiments of M. Becquerel also prove the correctness of the conclusions of Humboldt from the observations upon the temperatures observed at thirty-five stations in North America, extending over 40° in longitude, namely, that the mean annual temperature over this extent of country has not been sensibly changed by the great destruction of wood which has taken place during the time of the observations. It has thus been satisfactorily proved that in these latitudes the destruction of woods has only a very slight influence upon the mean annual temperature of a country.

THE BOILING-POINTS OF DIFFERENT LIQUIDS.—The laws relating to the boiling-points of different liquids, at the ordinary pressure of the atmosphere, have lately been investigated by Mr. Tate, and the results of his experiments are published in the last number of the "Philosophical Magazine." He has made experiments with solutions containing the chlorides of sodium, potassium, barium, calcium, and strontium; the nitrates of soda, potassa, lime, and ammonia; and the carbonates of soda and potassa. He has found for all these salts that the augmentation of boiling temperature may be approximately expressed in a certain power of the per centage of the salt dissolved. The salts enumerated may be divided into four distinct groups; namely, first, the chlorides of sodium, potassium, and barium, and the carbonate of soda; second, the chlorides of calcium and strontium; third, the nitrates of soda, potassa, and ammonia; fourth, the carbonates of potassa and nitrate of lime. In each of these four groups, the augmentations of boiling temperature of the solutions have a constant ratio to one another for an equal weight of salt dissolved. He has also ascertained by experiments that for an equal weight of salts the boiling temperatures are (approximately) in the inverse ratio of the chemical equivalents of their bases, and in the case of the nitrate of lime and the carbonate of potassa with the equivalents of the entire salts. Although the law thus indicated is not strictly true, it is sufficiently exact to warrant further inquiry, and the cases in which it is found to apply are too numerous to be referred to accidental coincidence.

LIQUID GLASS.—Dr. Reeves, of Melbourne, prepares liquid quartz, glass, or flint, by fusing together in an iron ladle, in the heat of a smith's forge, 1½ pints of powdered quartz and 1 of pearl-ash (dry) until they form a glass, which, when cool, should be powdered and boiled with four pints of water, in an iron pot, for four hours, or until dissolved. Water should be added from time to time to keep up the quantity, and when all the powder is dissolved the liquid should be boiled until it is of the consistence of thin treacle, and then, as soon as cool enough, bottled. It can be thinned by the addition of water. For indoor use—for giving a coating of glass to wood or paint, or the paper of rooms, or paper boxes—it is equal to the finest varnish, and several hundred per cent. cheaper. It may be used alone, but for ceilings and walls, either white-washed or colour-washed, the wash should be applied and allowed to dry; then apply the liquid glass (one pint to three of water) with a clean wash-brush. Wood or stone work, which it is not desirable to colour, should be washed with the liquid glass (one part to three of water), and then while wet with a solution of sal-ammoniac (½lb. to a gallon of water). Wood intended to be exposed in water or underground should be first steeped until thoroughly saturated in the sal-ammoniac solution, and then placed in the liquid glass (one pint to six of water), and allowed to remain for several days. If the wire of a telegraph cable was placed in the centre of an untarred hempen cable, and the cable passed through the liquid glass, and then through the solution of sal-ammoniac, it would be effectually protected from the action of the sea-water.



The Comet, as seen shortly after twelve o'clock on the night of June 30th, 1861. The star represented is β Auriga.

THE GREAT COMET OF JUNE AND JULY, 1861.

ANOTHER great comet! Two years and three-quarters have scarcely passed since the wondrous form of Donati's comet glided for ever from our sight, and again have we had before our eyes a strange mysterious form; and the wonders of a cometary nucleus have once more been shown in the fields of our telescopes. I must attempt to tell its story. It has come before us, the hero of the narrative, in all its grandeur and "speciality," presenting itself, even to astronomers, with no preliminary explanation, giving them the task of unravelling its character, as the course of its adventures might tend to develop it.

"The sudden appearance of the comet in Europe," says Mr. Hind, "is fully accounted for by the course it was following among

the stars." It was too nearly in the same direction as the sun to be detected up to June 29th. Since then it rapidly mounted northward, and, from its near proximity to the pole, has never set since the 29th of June.

A few persons are said to have seen it on the evening or night of Saturday the 29th; for instance, Sir John Herschel states that a resident in the village of Hawkhurst, Kent, observed it at that time, his attention having been drawn to it by its being taken, by some of his family, for the rising moon. But the merit of the first observation of it, deserving the name of a discovery, belongs to no chance gazer at the morning sky, but to one who has for many years devoted his attention to astronomy and the kindred sciences, losing no opportunities of making meteorological observations from his station at Clifton. I allude to William Corbet Burder, Esq., F.R.A.S., the discoverer of the comparatively small but beautiful comet of March and April, 1854.* He is an occasional contributor to the pages of RECREATIVE SCIENCE.

His discovery of the present large comet was briefly notified by him in the *Times* of July 1st. For a detailed account of the circumstances connected with his discovery, I cannot do better than copy verbatim from the narrative he has kindly supplied at my request.

"It so happened that I was *looking* for a comet when I first saw this one, the first recorded observation of which appeared in the *Times* of July 1st. Happening to be awake at 2.40 on June 30, and happening to notice that the sky was unusually clear, the thought occurred to me, now is the time to see a comet, if there should happen to be one; and the idea had hardly passed through my mind, when I saw what appeared to be a star seen through a hazy cloud. Is it a star? No, certainly; for it cannot be Capella, it is too much to the north; besides, how could a star look hazy in a clear sky? Throwing up the window sash to satisfy myself as to the position of Capella, which I then saw at once, I said to myself it *is* a comet without doubt! What was to be done? The daylight was fast approaching, even Capella was becoming faint. Can I get any instrument ready to measure its position? No; I may lose it altogether. Another look. Suppose it should not be seen by any one else owing to the cloudy weather? Yes; then I will call a witness. My brother, who slept in the next floor above, must see it, so I called him up, and, after pointing to certain chimneys near South Parade, I soon got him to see it, and we both agreed that it could be nothing else than a comet.

"At 2.55 a.m., it happened to be in a position for getting a very fair approximate measurement, by taking its relative place as compared with the chimneys (Fig. 1). The dotted square I measured at leisure with the sextant, by taking the angle subtended by the side A B.

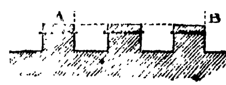


FIG. 1.

"The daylight at 3.10 had not quite put it out, so I got another rough observation when it was sensibly in a vertical line with the south side of the next chimney (Fig. 2.) The altitude of the comet I then measured with a pocket Klinometer (Fig. 3.)

"By means of these two observations I ob-

* This comet was discovered by Mr. Burder, at Clifton, at 7.30 p.m., on March 28th, 1854. It remained visible but a short time, becoming almost imperceptible even in a powerful telescope at the end of a fortnight. When first seen by Mr. Burder it was a very faint object against a bright sky, and near the horizon, and would have escaped Mr. Burder's notice but for the fact that he happened to be searching for a star in that particular spot at the time, having just mounted a celestial globe after a new mode, and being desirous of putting his arrangements to the test, as soon as the twilight would allow. Mr. Burder immediately wrote a report of his discovery to the *Bristol Gazette*, and to the *Morning Chronicle*, and also telegraphed it next morning to the Astronomer Royal at Greenwich.

tained its place approximately: Right Ascension, 6h. 16m.; North Polar Distance, 52°; or North Declination, 38°.

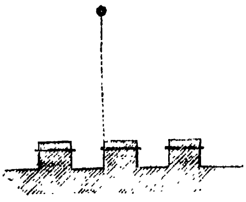


Fig. 2.

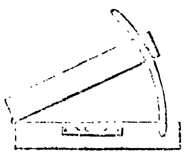


Fig. 3.

"I was thus prepared to look for it in the evening within a few degrees of its true place. A bank of clouds prevented my seeing it early, and it was about 9 p.m. when they cleared off. I then was astonished to see that our hazy, nebulous comet was transformed into a magnificent one with an enormous tail. The pleasure with which I gazed at it on Sunday evening you may guess, but it is quite indescribable."

Truly, it must have been so—the strange "thrill of possession" must have mingled with Mr. Burder's feelings on observing this comet, and for the first time realizing how great was his prize.

There was no lack of discoverers on the *evening* of the 30th! *Their* sensations, too, were enviable, as so splendid an object quickly unfolded its splendour before them in the increasing twilight. Surely the present "rising generation" will feel a much more lively interest in the comet subject than my contemporaries are likely to have felt at an early age. I saw "Halley's Comet" from my school-room window in 1835, and had no opportunity of seeing another for eighteen years, when after much trouble I saw the comet of 1853, for scarcely *five minutes*, before it sank one evening below the horizon. The comet of 1854, too, I saw only on one evening. Four years later, however, we had indeed a comet, that exquisite comet of Donati, which almost all who read this must have seen, and never can forget! Unlike the present visitor, which from our first glimpse of it, has progressively diminished in the distance, Donati's evermore gained upon us, becoming larger and larger, in apparent size, as it neared the earth, up to October 10th, shortly after which the southern horizon concealed it. The comet of June and July, 1861, it is agreed, is "a much finer object than that of 1858." Be it so; I feel sure a strong party of adherents are still on the side of the Donati. "Recollect," as Admiral Smyth said, when drawing a comparison between "Donati" and the comet of "lang-syne," that of 1811—"recollect, that in these remarks I mean nothing disrespectful to the Donati,"—while I give the impressions of various observers of the magnificent spectacle seen a month ago. Mr. Lassell, the celebrated astronomer, thinks that this comet, seen on a dark sky, would exceed in splendour any which has visited us this century. It was seen by Mr. Lowe, of the Beeston Observatory, at 7h. 49m. p.m. Not only in strong twilight, but when the sun was actually above the horizon. Mr. Webb, a practised observer, as well as an industrious collector of astronomical facts, considers that nothing equal to it has appeared since a comet at the end of 1680 and beginning of 1681, which brings us back to the days of Newton. Sir John Herschel writes of it:—"On June 30th" it "far exceeded in brightness any comet I have before observed, those of 1811 and the recent splendid one of 1858 not excepted. Its total light certainly far surpassed that of any fixed star or planet, except, perhaps, Venus at its maximum." (Reader, recollect your impression of Venus at her brightest, and bear in mind that you have seen a comet worthy of being compared to that lovely light!) Mr. Burder says, exclusive of the personal interest he felt in the reappearance of the comet on the evening of June 30th, its magnificence was so great that no celestial phenomenon which he had ever seen had so much astonished him.

A friend of mine, describing its appearance as seen from Brest harbour, writes:—"We had a capital view of the comet at Brest on the 30th. It was exceedingly brilliant, and the reflection in the sea was equal to that of a small moon; the tail extending quite to the zenith." And very similar was its appearance at Naples. "The comet," writes the *Times'* correspondent, "is so brilliant that it casts almost the light of a moon on every object. The Astronomer Royal, Capocci, has published his report of its unexpected appearance:—"Its splendid nucleus has a planetary diameter, and a light superior to that of a star of the first magnitude. Its tail is, as usual, diametrically opposite to the sun, and turned from it; its axis was a little below the polar star on the 30th of June, in the direction of Vega in Lyra, near which were still to be seen traces of its nebulosity, so that its entire length was upwards of 90°." My own note of its brilliancy (see illustration at commencement) is as follows:—"The nucleus, by the naked eye, was star-like and very bright. Through smoked glass (a piece which I had prepared of different degrees of shade for observing the sun) I could conceal Capella by a part which still showed the nucleus of the comet, and even part of the neighbouring brightness."

I may here mention that I cannot lay claim even to the small merit of having been a *discoverer* on the evening of June 30. The subject of comets was far from my thoughts at half-past ten that evening, although I was conscious of an undefined impression that the events of that day were not over, when a kind friend sent a message to me, recommending me to come out of doors and see a "strange appearance in the sky;" and I think he must have found the pleasure which I evinced equal his expectations.

Nor was its *splendour* the only recommendation of this comet. One of its surmised *adventures* on June 30 was of extraordinary interest and wonder.

Mr. Hind says* that it appears not only possible, but even probable, that in the course of June 30th "the earth passed through the tail of the comet, at a distance of, perhaps, two-thirds of its length from the nucleus. The head of the comet was in the ecliptic at 6 p.m. on the 28th of June, distant from the earth's orbit 13,600,000 miles on the inside, its longitude, as seen from the sun, being 279° 1'. The earth at that moment was 2° 4' behind that point, but would arrive there soon after 10 p.m. on Sunday last. The tail of a comet is seldom an exact prolongation of the radius vector, or line joining the nucleus with the sun; towards the extremity it is almost invariably curved, or, in other words, the matter composing it lags behind what would be its situation if it travelled with the same velocity as the nucleus. Judging from the amount of curvature on the 30th, and the direction of the comet's motion, as indicated by his orbit already published, Mr. Hind thinks the earth would very probably have encountered the tail in the early part of the day, or, at any rate, it was certainly in a region which had been swept over by the cometary matter shortly before." [See POSTSCRIPT.]

In connection with this subject he adds, that "on Sunday evening, while the comet was so conspicuous in the northern heavens, there was a peculiar phosphorescence, or illumination of the sky, which I attributed at the time to an auroral glare. It was remarked by other persons as something unusual, and considering how near we must have been on that evening to the tail of the comet, it may, perhaps, be a point worthy of investigation, whether such an effect can be attributed to our proximity thereto. If a similar illumination of the heavens has been remarked generally on the earth's surface, it will be a significant fact."

* Quoted from the "London Review," July 13th.

A correspondent of the "London Review," Thomas Crumplen, Esq., says that two of his friends, Mr. Townsend and Mr. Parkin, irrespective of each other and of himself, had both remarked the unusual aspect of the sky on the night of June 30th, and had informed him of the fact previous to the appearance of Mr. Hind's announcement. Mr. Lowe, of Highfield House, also confirms Mr. Hind's statement of the peculiar appearance of the heavens on the 30th of June. "The sky," he says, "had a yellow, auroral, glare-like look, and the sun, though shining, gave but feeble light. The comet was plainly visible at a quarter to eight o'clock (during sunshine), while on subsequent evenings it was not seen till an hour later." Without being aware that the comet's tail was surrounding our globe, yet being struck by the singularity of the appearance, he recorded in his day-book the following remark:—"A singular yellow, phosphorescent glare, very like diffused Aurora borealis; yet, being daylight, such Aurora would scarcely be noticeable." *

Such an observation, placed, as it were, half against the observer's will, as an undeniable fact, though occurring rather contrary to known theory, has much value.

A point which required to be settled as soon as possible after the comet's appearance was this:—Is it a known comet? Has it ever visited the earth's vicinity before? Is it not probable that it is the "Comet of Charles the Fifth?"

The state of the case concerning the last-named celebrated comet is probably familiar to the readers of Recreative Science, being clearly stated by Mr. Chambers in vol. i. at p. 139. The comet appeared in 1556, and being supposed to be identical with that of 1264, was at one time expected to return in 1848. Taking into account, however, the various planetary perturbations, astronomers calculated that its return might be delayed to a period between the years 1858 and 1860.

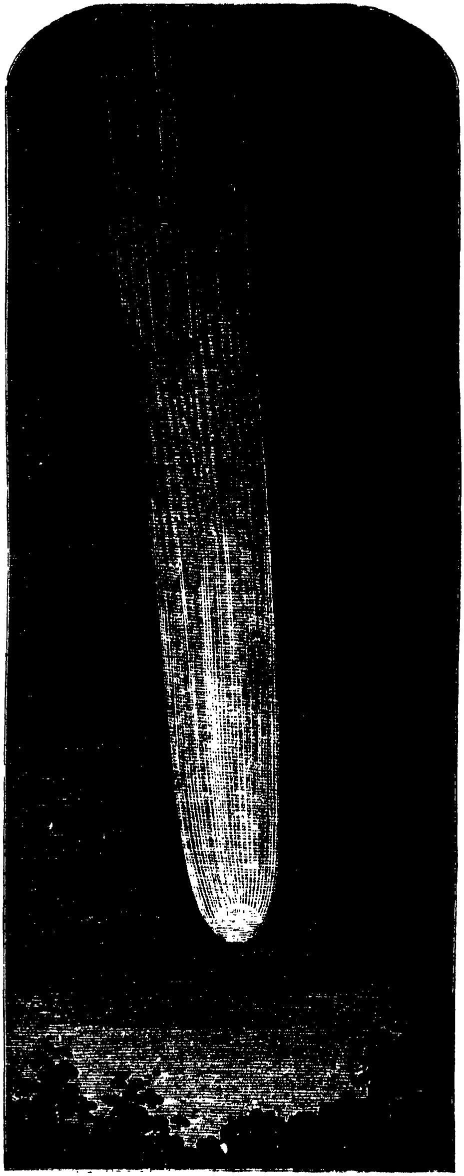


Fig. 4.—The Comet, July 1st, 11.50 p.m.

Any comets, especially such as were visible

* "London Review," July 13th.

to the naked eye, appearing within that interval were consequetly scanned with much interest. But Donati's comet moved in an orbit which was certainly not that of the "expected comet." Again, a rather bright comet appeared in June, 1860, remaining a brief time in sight (see RECREATIVE SCIENCE, vol. ii. p. 99), but proved to be a complete stranger. A similar verdict was found regarding a comet very faintly visible last May, and the great comet now above the horizon, though on June 30th occupying a position in which the comet of 1556 might possibly have reappeared, proved by its path during the immediately succeeding days that it was not that comet. To my mind, the language of astronomers concerning that unpunctual orb becomes almost piteous. "It may be said," says Mr. Pogson, in Messrs. De La Rue's beautiful little almanac for this year, "to have been due since 1845, but need not be despaired of even two or three years hence." But it has been so long the coming comet, that as each year passes without producing it, Professor Grant's words recur with fresh humour to one's mind—"It is to be hoped that the expected stranger will, in due time, respond to the elaborate calculations of which it has formed the subject."

The new comet is believed to be one which has never before been observed. I have now to follow its progress during a few weeks after its first appearance. It seems

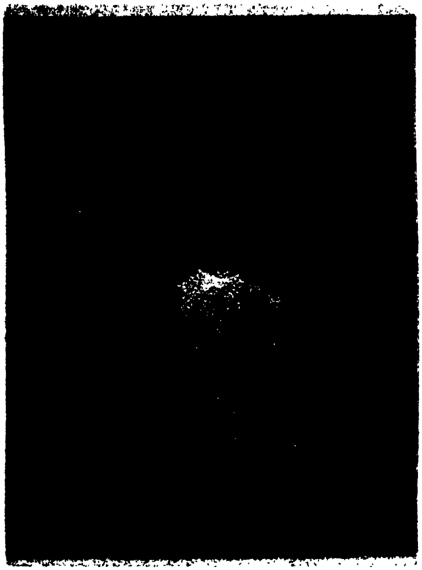


FIG. 5.—Nucleus of the Comet, as seen with day eye-piece of a telescope of two inches aperture, June 30th, 12 p.m.

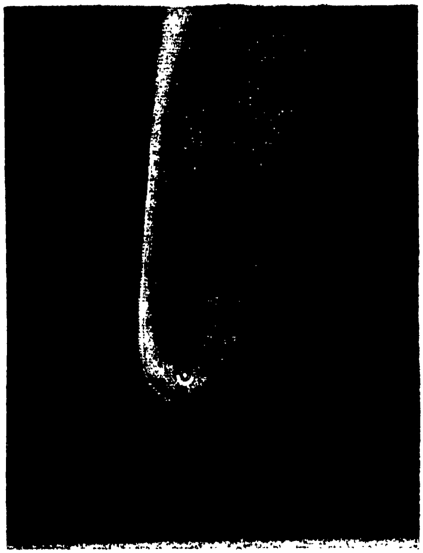


FIG. 6.—Nucleus of Donati's Comet on October 4th, 1858, as seen with the same telescope and same magnifying power.

to have been not very advantageously observed in England on July 1st, owing to cloudy weather. Here (near the centre of Ireland) it was seen in great beauty (Fig. 4). The rapid change in its position was very striking (see Plan, Fig. 8). Its head appeared certainly smaller than on the preceding evening. The nucleus, seen in a small two-inch Dollond telescope, presented much the same appearance as on June 30th (Fig. 5). The surrounding coma quite filled up the

field of view, contrasting curiously in this respect with the head of Donati's comet, a figure of which, on one of its best days, is given for the purposes of comparison (Fig. 6). The nucleus through this telescope became a mere point, though to the naked eye appearing large and circular. As the night wore on and sunrise approached, the comet inclined towards the left, being carried by the general movement of the heavens. On the evening of July 2nd, my view of the comet's tail was much impeded by numerous brush-like clouds which covered the sky. In England, on the contrary, they saw it in great splendour. Mr. Birt thought the light of its nucleus to equal in intensity the average brilliancy of Venus, but to partake more of the character of the light of Jupiter. He traced its tail as far as τ Herculis. The Rev. F. Howlett observed it even farther, namely, to 68 Herculis; and Mr. Chambers saw it to the wonderful distance of $109\frac{1}{4}°$, namely, from near o in Ursa Major to a distance south of α in Ophiuchus. He discerned a faint branch or fan to the tail, and estimated the breadth of the main part of the tail at 3°, and of the whole, including the "fan," at 7°. Sir John Herschel, on the same evening, possibly from a less clear state of the atmosphere, did not observe the tail with certainty to a greater length than 72°, and also observed "no bifurcation or lateral offsets." He also considered it had no curvature like that of 1858, but had some irregularity of general form, which imparted to it "an unsymmetrical aspect." Mr. Birt, however, says "it presented the usual graceful curve convex towards Polaris," namely, the opposite way from Donati's.

On July 3rd, Mr. Hind traced the tail to the length of 100°. After this date observers note the unmistakable diminution of the comet's splendour, during its progressive retreat from our vicinity. On the morning of July 5th, I felt interested in observing its relative brightness as compared with α in Ursa Major. It was quite as bright as α to the naked eye (Fig. 7); but very much the contrary in the telescope. Yet the nucleus and the neighbouring brightness continued very visible facts in the telescope, till near three o'clock. 2.55.—Comet almost invisible in the telescope, difficult to catch; α was easy to catch, but with the

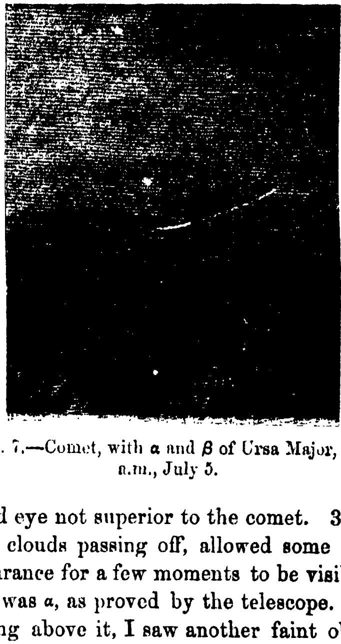


FIG. 7.—Comet, with α and β of Ursa Major, 2.40 a.m., July 5.

naked eye not superior to the comet. 3.3.—Thin clouds passing off, allowed some faint appearance for a few moments to be visible." That was α, as proved by the telescope. On looking above it, I saw another faint object—the comet—perhaps more plainly than I had seen α, but entirely failed to catch it in the telescope. Within five minutes I had fairly "outwatched the Bear," which faded exactly at the same time as the comet.

The "London Review" of July 6th and 13th contains many interesting details and figures of this comet's nucleus, as seen with the various celebrated telescopes in public and private observatories. My limits do not permit me to detail these fully. A graphic passage from Mr. Webb's letter must suffice to show the kind of spectacle presented in a good telescope:—"A minute brilliant point

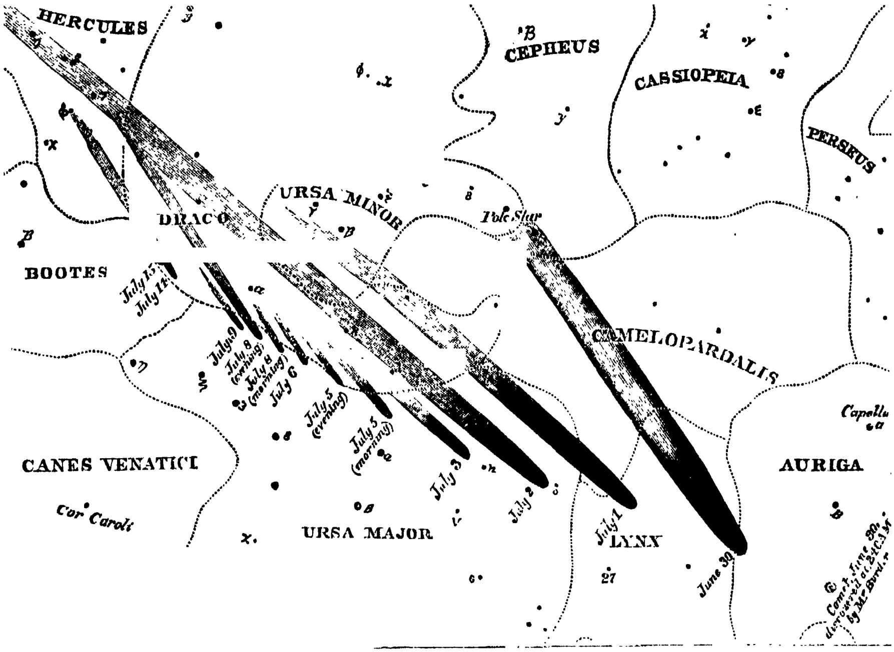


FIG. 8.—Plan of the Apparent Path of the Comet during part of the time in which it has been visible; intended to show the successive changes of its position, form, and apparent dimensions, as observed by the writer and others.

was situated a little way from the vertex of a bright parabolic arc, and great part of the field was filled with irregular curved flakes and trains of misty light, the whole presenting a picture like that of a miniature full moon, shining in a sky diversified with light cirrus clouds."

The annexed plan of the comet's path during the time of its greatest brightness will give some idea of its changes, and of the points in which it differed from Donati's. The figure of Donati's at its largest, on October 11, is drawn on the same scale, for the sake of comparison (Fig. 9). I look on this little sketch with some complacency, because, though it does not contain nearly as much variety of outline as that shown in Mr. Bond's view, taken in the clearer atmosphere of Harvard Observatory, in the United States (see RECREATIVE SCIENCE, vol. ii., page 147), I have been pleased to observe that all my

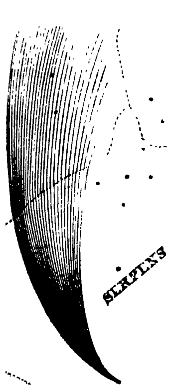


FIG. 9.—Donati's Comet, on October 11, 1858.

sketches of Donati's comet correspond closely to those of M. Struve, the eminent Russian astronomer, in his "Pulkowacr Beobachtungen des Grossen Cometen von 1858."

There will be abundant opportunities of observing the present comet fade away in the distance. It will not bound off the stage as it entered it, or as Donati's made its exit; but will continue so far circumpolar that it will never set, very nearly up to the middle of August. Mr. Hind gives its place up to July 28th, supposing it will then have ceased

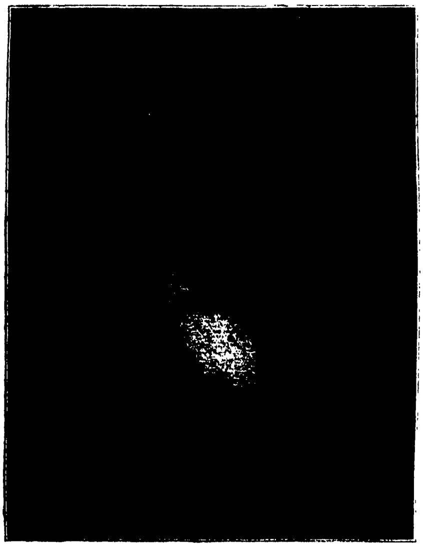


Fig. 10.—Nucleus of Comet, July 15th, with the same magnifying power as that employed on June 30th.

to be visible to the naked eye. My latest sketch of the nucleus was that of July 15th (Fig. 10), showing the diminution in the apparent size of the comet.

Mr. Hind's calculation, dated July 13, of some particulars respecting the comet may appropriately close this slight sketch of its story:—

Passage through perihelion, June 12, at 4h. 0m. 7s. a.m. meantime at Greenwich.

Inclination of orbit to elliptic, 85° 38′ 32″.

Heliocentric motion, direct.

Mr. Hind elsewhere states that its distance from the sun at perihelion was 76,000,000 miles. Its distance from the earth on June 30, 13,000,000 miles; on July 14th, 43,000,000 miles; and its distance for July 28th Mr. Hind calculates at 78,900,000 miles.

Breadth of the nucleus on July 2nd, 400 miles.

True length of the tail, 16,000,000 miles.

MARY WARD.

Bellair, Moate, Ireland.

Postscript.—Since writing the foregoing account, I have received a valuable communication, kindly sent to me at the request of the Rev. F. Howlett, F.R.A.S., by Alexander

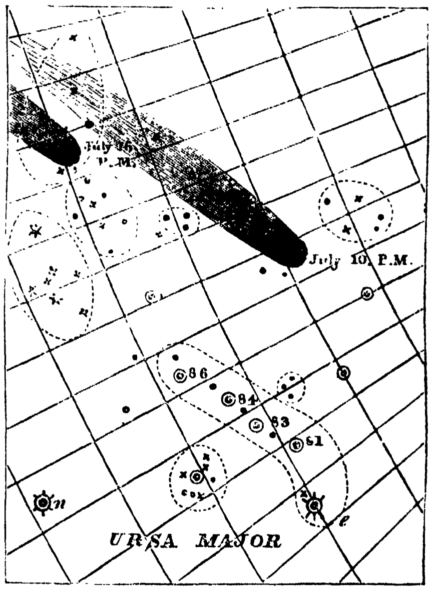


Fig. 11.—"Burder's Comet leaving the Bear. Positions at midnight of July 10th and 16th among the stars of Harding's charts. The stars grouped together for recognition."—Rev. F. Howlett and Alex. S. Herschel.

S. Herschel, Esq., conveying some informa-

tion collected by his father, Sir John Herschel, on the subject of the comet. Mr. Howlett and Mr. Herschel have supplied me with the annexed plan of the comet's position for July 10th and 16th (Fig. 11).

With regard to the singularly curious subject of the earth's probable passage through the comet's tail on the afternoon of June 30, Mr. Herschel writes :—" Collingwood, Hawkhurst, Kent. The comet was seen here on Saturday evening, June 29th, by two casual observers, who 'took it for the rising moon' (not thinking of the point of the compass), 'brighter than Jupiter or Venus, and round like a ball.' The tail would then, according to Mr. Hind's elements, be pointing to the south, not having swept over our earth to the north side of it till Sunday afternoon at 6½ p.m., at which moment, Mr. Lowe at Nottingham observed (unwittingly) a phosphorescent appearance in the sky. I have a recollection of the same sombre appearance, and people recall to have remarked on that afternoon 'that the evenings weredrawing in.' This, however, is vague. On Sunday night at 10 p.m., I first saw the comet at the cry of some ladies who walked on to the balcony looking north from Paddington, over the Hampstead and Highgate hills of London; they at once exclaimed—'There's a fire-balloon!' The tail was not then long, but as twilight disappeared, it reached two-thirds of the way to Polaris, from the stars in Telescopium Herschelii, where the nucleus was placed. Later, while I scrutinized it through an inch and half finder telescope, and a pair of Frauenhofer prisms, the tail reached through and above Polaris. We were then looking at the nucleus along the tail, which was considerably curved to the left, as if a tassel were drifted leftward from the upright stem. The involucres, or caps, or envelopes of the head, being seen very obliquely along the straighter part of their curvatures (like looking down the long steep parts of coffee-cups one within another), presented luminous patches, producing an effect that greatly detracted from the uniquely central stellar appearance that the head wore to casual observation upon later nights of its appearance.

"Already, on July the 2nd (Tuesday night), these luminous patches in front of the head had disappeared, one cap being drawn as it were over another, as the comet, rising above the ecliptic, turned its tail upward to our view." (Fig. 12.)

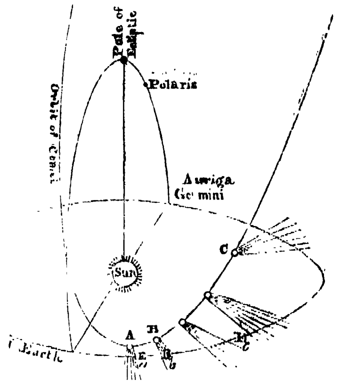


FIG. 12.—A, comet, seen head upwards from the earth, "looking like a ball," on Saturday evening, June 29th. B, comet in node of its orbit, cutting the ecliptic just in front of the earth, June 30th, 6½ p.m., long. 279° 28′. E a, the earth on June 29th. E b, the earth on June 30th, at 6½ .— E c, the earth on July 10th. C, the comet on July 10th.

Mr. Herschel also incloses to me a letter to Sir John Herschel from Mr. Hind, in which the latter mentions that the comet was seen by some persons in the north of Ireland at 10 p.m., on June 29th, surrounded by the "coma" only. The tail, he adds, "must then have been nearly directed on the earth."

All these are, perhaps, but instalments of the tidings which may reach us of this very singular episode in the comet's history.

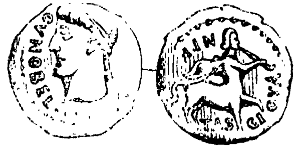
M. W.

COINS OF CYMBELINE AND OTHER BRITISH PRINCES.

COINS have been attributed to other British chiefs of the times of Tasciovan and Commius, but this attribution appears at present uncertain; and I therefore proceed to the consideration of the coinage of Cunobelin, or Kymbelin (the "Cymbeline" of Shakspeare), who was a son of Tasciovan, as shown by the inscriptions on his coins. On the death of Tasciovan, Cunobelin, or, as his name is Romanized, Cunobelinus, appears to have received a share of his father's dominions, embracing great part of Suffolk and Norfolk; Camulodunum, the modern Colchester, having apparently been the chief town of the new state, as a great number of the coins of this prince have the letters CAM, the initials of Camulodunum The gold coinage had considerably decreased in weight at the time of the accession of Cunobelin; the earliest coins of the large class of gold, weighed from 115 to 118 grains, while in the reign of Cunobelin they only reach 83 to 84 grains. Some of the barbaric copies of the "Philips" had already been gradually reduced to about 103 grains, and then to 94, the rudest (and latest) being scarcely more than 91 grains.

It was the form of inscription on the coins of Cunobelin which led to the first great discovery that opened up the way to nearly all the others, which have recently thrown so much light on the respective coinages of the native princes of Britain. The inscription TASCIO. F. or TASCIOVANI. F. is the inscription which has been the means of shedding this new light upon the subject. Now that its true import is known, it seems so simple, that the former misinterpretations appear incredible; and yet the wildest of those explanations were received by excellent numismatists, previous to Mr. Birch's successful interpretation. In Ruding's time, it was misread as TASCIOVANIT; while those with the fuller legend, TASC. FIL, have been read with R instead of L (as previously described) by more than one experienced antiquary. Some of the coins of Cunobelin have the ancient British and Gaulish symbol, the sow, for the device of the reverse; others have a centaur, and a great number bear types of Roman origin, and were evidently executed by Roman artists; Cunobelin having, in consequence of his education in Rome, sought to give a Roman character to the coinage of his state.

The portrait on the coin engraved below



is quite in the Roman style of the reign of Augustus, as also is the centaur of the reverse. On the obverse, in front of the portrait, the inscription is CVNOBELINVS, the letters after L being indistinct, though they are perfect on other coins of similar character. On the reverse we find TASCIOVANI. F. and these are the two inscriptions which, combined, were so successfully interpreted by Mr. Birch, in a paper read before the Numismatic Society, on the 12th April, 1844; which was so conclusive, and supported by such a body of evidence that nearly all those who had not some cherished project of their own to support, at once acknowledged that the right interpretation had been at length arrived at; and Mr. Birch's discovery was at once received as one of the series of brilliant numismatic discoveries which were yearly distinguishing the successful labours of modern numismatists. Mr. Birch read the inscription, for the first time, as "Cunobelinus Tasciovani filius" (Cunobelin, the son

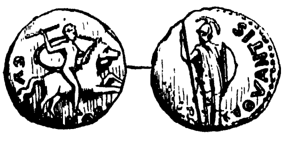
of Tasciovan), and in support of this theory adduced examples from the Roman coinage; especially that on the well-known copper coins of the first Roman Emperor, on which he is described as the son of the deified Cæsar, in the inscription, AVGVTVS. DIVI. F., for AVGVSTVS. DIVI. FILIVS (Augustus the son of the god). There are many other examples of a similar form of inscription on the Roman coins, which caused the suggestion of Mr. Birch to be at once received by nearly all our British numismatists. There can indeed be no doubt that Cunobelin adopted this form of proclaiming on his coinage his hereditary right; which was, indeed, stronger in his case than in that of the Roman imperator, who was only the *adopted* son of a dictator, who had no *hereditary* right to transmit; while Cunobelin, as the son of Tasciovan, was the legitimate successor of a long line of hereditary chieftains.

This interpretation has, nevertheless, met with some opposition. Continental numismatists still withhold their consent; while the theory of F standing for FIRBOLG, is still maintained by at least one ingenious numismatist and his followers in England. The CVNO. TASC. FIL., being read as CVNOBELINI TASCIOVANI FIRBOLG. The last word, as a generic name, being supposed to be left undeclined, as are the Hebrew names of the Bible in the Greek Septuagint. The inscription thus perfected, is translated as "Of Cunobelin, the ruler of the Firbolgi;" the first *of* having reference to money, which in this interpretation is supposed to remain unexpressed, as on Greek coins; as, for instance, on the coins of Syracuse, ΣΥΡΑΚΟΣΙΩV, means *money* of the Syracusans. It is said, by the author of this interpretation, that the word Firbolg is found in full on some of the coins of the southern Britons; but it is certain that on the coins of Cunobelin, on which the letters FIR are found, the R is very doubtful. Mr. Evans, a supporter of Mr. Birch's theory, remarks: "If the R be indeed there, as stated by Mr. Wigan, it should stand thus, FI. R., which would be, in full, FILIVS. REGIS. TACIOVANI, son of the king Tasciovanus," only making a still fuller inscription in the sense of Mr. Birch's translation. Finally, to dispose of this difficulty, it may be asked, if the word Tasciovan, or Tasciovanus, is to be accepted as a title and not a name, how is it that the word occurs *alone?* and why may not the R, if indeed it be there, be intended to read as L, the letters L and R being often convertible—as in the words *calf* and *balm*, in which, though the L is written, the R is pronounced; or, as in the Latin word *aposto*L*us*, which in the French form is *apot*R*e;* while *episto*L*a* becomes *epit*R*e*.

Not, however, to depend upon such close special pleading as the last points urged, we may find better support for Mr. Birch's case in the striking analogy of similar inscriptions on the Gaulish coinage. The example given (I believe by Mr. Birch himself) is a coin of the Gaulish chief Vosimos, on which is the inscription VOSIMOS. DVMNOCO. NEPOS. (Vosimus, the grandson of Dumnoco.) This inscription explains the long-doubtful inscription of the coins of Orgetorix, chief of the Helvetii, which sometimes read ORGET. N. ATPIL. The Romans, it would appear, favoured the system of hereditary right among the Gallic and British chieftains, often replacing a dethroned dynasty, which necessarily became subservient to its benefactors, and would naturally be led (after a Roman custom) to stamp the nature of their restored right on their coinage. The ATPILINE, which has been found on a British coin, may serve to prove that it is one struck by a British prince, who, like the Helvetic prince Orgetorix, claimed descent from Atpilus. The coins of the Gaulish prince Germanus, once supposed to read INDVTILLIL, are found to be all from a single defective die; other coins of that prince reading plainly INDVTILLI. F. They are direct copies of a denarius of Augustus,

struck by the Roman moneyer L. Vocconius Vitulus, the legend of which reads AVGVSTVS DIVI FILIVS, the type of the reverse being the butting bull. On the Gaulish coin, the diademed head is either a portrait of the chief, or an impersonation of Gallia, while the legend, GERMANVS INDVTILI FILIVS, proclaims Germanus a son of the celebrated chief Indutilus.

Some of the coins of Cunobelin exhibit the name of Tasciovan with the genitive formed in a different manner, as Tasciovantis, or Tasciovantis,*f.*; as shown on the reverse of the coin engraved below. The device being a



warrior, with lance, shield, and plumed helmet, in the Greek style. The obverse of this coin has a horseman, with a large oval shield, and a short javelin, with the legend CVNOB. Tasciovani and Tasciovantis are said, by advocates of the Firbolgian theory, to mean *imperatoris* and *imperantis*, and accepting the F as the first letter of the name of a tribe (whether of the Firbolgi or some other), the inscription is read as "(*money*) of Cunobelin, the ruler of (or, ruling) the Firbolgi." This irregularity of the two genitives is not very easily explained, but it does not shake Mr. Birch's position; nor is the interpretation offered by any means tenable.

Presuming, therefore, that the meaning of the F or FIL on the coins of Cunobelin is fully established, we may proceed to notice briefly their general character. The Roman style of his coins, in all the metals, has been before alluded to; and a silver coin, mentioned by Mr. Evans, and now in the British Museum, having Hercules and the Nemæan lion for the type of the reverse, is at once a proof, both from the subject and its style of execution, that classical types were directly copied by Roman artists for the coinage of this British prince. The well-known type of the closed temple of Janus is without doubt directly copied from the same type on the coinage of Augustus, as well as many others of a similar kind.

The other sons of Tasciovan do not appear to have been nearly so much subject to the Roman influence as Cunobelin—either from the more remote situation of part of their states, or from the fact of their not having, like their brother, received a Roman education. A coin of Epaticus, a son of Tasciovan, previously unknown, was found, in 1857, at Farley Heath, near Guildford, and is now in the collection of Mr. Whitbourn, at Godalming. Several other gold pieces were found with this interesting coin, but they unfortunately found their way to the melting-pot, before any one conversant with their numismatic importance became aware of the discovery. The coin of Epaticus is of red gold, and weighs eighty-two grains. It has for types a naked horseman on the obverse, with the large oval shield in the style of a coin previously described, and the letters EPATIC, or

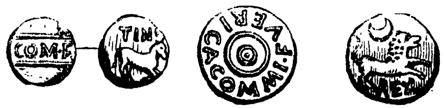
EPATICCV. On the reverse it has an ear of wheat, and the same TASCI . F . of the coins of Cunobelin, which must be read TASCIOVANI. FILIVS (the son of Tasciovanus). The type was previously unknown to our leading numismatists; but in Philemon Holland's translation of Camden, there is an engraving of one precisely similar. That antiquary, however, misread the inscriptionas CERATIC, and attributed it to "that Caractacus, whose praises Tacitus highly extolleth." This engraving was expunged in Gough's fine edition of Camden, as unknown, and no doubt

deemed spurious; an ancient *Spanish* coin being introduced in its place as more *certainly* British. Such are the occasional mistakes of the most accomplished archæologists. Pegge and Stukely, on the other hand, both copied this coin, fascinated with the idea of its attribution to the British hero Caractacus, making it read CARATIC, to suit their wishes rather more completely. Speed, who has engraved a coin of this type, also attributes it to Caractacus, though he reads it rather more correctly, CPATICA. Others made it CEPATILA, and read the letters as Greek, which were certainly in occasional use at the time, contemporaneously with Roman, and a coin of Cunobelin is said to exhibit this peculiarity. There can, now, be no doubt, however, that the name is identical with that found on small silver coins, which reads plainly EPATIC. These small coins have Hercules with the lion's skin on the obverse, and an eagle standing on a snake on the reverse. The name, on the discovery of this coin, was at first mistaken for Mepati, which reading is now entirely abandoned. It would seem that while Cunobelin had the eastern division of his father's dominions, with Camelodunum for his capital, Epaticus had a portion of the south-western, with possibly Vindonum of the Segontiaci as his chief city, which was situate near Farnham; and the coins of Tasciovan, with SEGO, may possibly have been coined there. The original name of Vindonum appears to have fallen into disuse, and one founded on the name of the tribe given in its place; as Caer Segont, the city of the Segontiaci, which is so called by Nennius. It became afterwards Romanized as Segontium. There is another British city at which this coin may have been issued, namely, the capital of the Bibroci, which was on Farley Heath, a remote spot, which the tribe afterwards abandoned for the more convenient site of the ancient Noviomagus (now Newbery). The town on the high land being abandoned for a site on the plain, originated, probably, the new name; Noviomag (Romanized Noviomagus), meaning the new town in the plain, from *mag*, a plain.

Having described coins of two sons of Tasciovan, this appears the proper place to examine one issued by a son of Commius. The coins with the name of the regulus, or ruler, Epillus, which have generally been found in the isle of Thanet, and near Margate, are now known to be those of a son of that chieftain, as the inscription COM. F has

been found on some coins conjointly with the name of Epillus. There are coins with the COM. F of small gold, apparently a fourth of the coins of the large moduli.

Tincomius and Verica appear to have been other sons of Commius, as their names, with COM. F, appear on a series of coins. A small

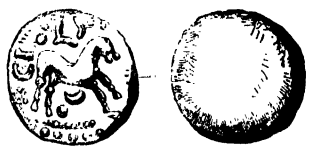


gold coin has COM. F on a square tablet, and on the other side a bridled horse, with TIN. On larger pieces of similar character, the horse has a rider, and some have TINC on a label, above and below which are the letters C. and F. There are a few coins which seem to read TINCOM., not as a part of TIN. COM. F, but of Tincomius. It is to this British prince, or regulus, it is thought, that allusion is made in inscriptions in Greek and Latin on the celebrated column erected at Ancyra in the reign of Augustus, on which many of the chief events of the reign are recorded; among others, the embassies of two British princes, or kings, whose names stand in the record as Damno Bellanus and Tinc . . . . . The latter name is imperfect, but it is highly probable

that it is part of that of Tincomius, the son of Commius. The coins of Tincomius and his brother Verica date, possibly, about 40 A.D. Dubnovellaunos, supposed to be a son of Cunobelinus, and a contemporary of Tincomius, seems to have abandoned the Roman *us*, for the Greek *os*, the Roman influence becoming fainter after the death of Cunobelin. He is probably the other prince mentioned in the inscription of Ancyra. A coin engraved in Mr. Taylor Combe's work on "Coins of Ancient People and Kings," and which is now in the British Museum; was attributed by that author to Dumnorix, a Gaulish chief of the Æduans, mentioned by Cæsar: but Mr. Evans, in a paper read before the Numismatic Society, attributes it, with more probability, to Dubnovellaunos. The obverse has a laureated beardless head, with DVMNO, and on the reverse is a winged horse. It is a quarter piece, and weighs fourteen and a half grains, showing by its light weight that it belongs to a very late period of the epoch of British independence. There are coins assigned to Togodumnus, another son of Cunobelin. To Caractacus, the third and most celebrated son of Cunobelin, no coins have been satisfactorily attributed, though it has been a favourite crochet of British antiquaries, ever since the time of Camden, to endeavour to twist various inscriptions, by various means, into names more or less resembling that of this popular British hero; but hitherto without effect.

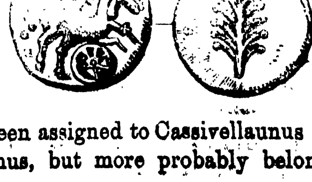
Andubratius is another British chief to whom coins have been assigned. The letters ANDO occur on a gold coin, beneath a horse, on the reverse, while the obverse is occupied by a kind of cross, formed by ornaments of a Celtic character. This is probably the same as the historical Mandubratius, the M being an error which has crept into the text of the MSS. in which the name has been recorded. British coins formerly read as SITMV, and attributed to Situmagus, are now read SAEMV or SAFMV, and are not as yet satisfactorily attributed to any British prince; but there are coins attributed to Arcovagus, another British prince, with somewhat more certainty. Coins with Cassi or Catti have been attributed, rather rashly, to Cassibellaunus, the name of a British prince sometimes written Cattivelanus; but they are rather thought, at present, to belong to the Cassii.

In speaking of the ancient British coins issued by the people themselves (of various tribes), and not by their princes, I may first allude to those coins with the letters ECE, or ECEN, which are attributed to the Iceni. This supposition is supported by the fact that the coins bearing these inscriptions have been found in Norfolk or Suffolk, the region occupied by the Iceni. Mr. Roach Smith has conjectured with great show of probability, that such coins as have, in addition to ECEN or ET, the letters DVRO or CAM, are the issue of particular towns. Those with *Duro*, for instance, belonging to Durobrivæ, and those with *Cam* to Camboricum, both towns of the Iceni. The coin of doubtful attribution, may possibly be a late coin of the Iceni, struck perhaps during the revolt of Boadicea, when Celtic art was fast



becoming extinct, but was making a last effort to preserve its nationality of character.

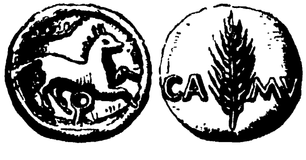
The British coins with Cassi or Catti



have been assigned to Cassivellaunus or Cattivellanus, but more probably belong to a

tribe, possibly the Cassii. The rude coin of the old Philip type is a coin of the description referred to.

The coins with CAMV only, and without the name of Cunobelin, were probably issued by the civic authorities of Camulodunum, which possibly, in common with other cities formerly independent, still possessed an autonomy, like the great Greek cities, which empowered them to strike their own money.



The coin represented above is one of the kind referred to; which may be compared with the one below, the last having the name of

Cunobelin as well as that of the city, from which it might be inferred that there was both a royal and a civic mint in that, and probably in other Celtic cities.

The remarkable coins with the letters BODVO or BODVOC on the reverse, without any other type or ornament, are now classed with the coins of British tribes or cities. These were the coins fondly attributed by our early antiquaries to the popular British heroine, Boadicea, queen of the Iceni, and some have thought fancifully to solve the difficulty by reading the letters as an abbreviated sentence, which they translate, still referring to Boadicea, "I fly from the war chariots." Others have insisted upon Boduo or Boduoc being the name of a moneyer, an explanation which cannot be admitted. That it is a late Icenian coin, I think there is no doubt, and perhaps it is not yet time to give up the Boadicea theory, if the inscription could be properly read. Perhaps BO. DV. OC, the latter read as IC, might lead us to BO (adicea) DV (robrivæ) IC (enensis). But we must leave such attempts at interpretation to the higher authorities. The coins with ANDO are attributed to Andovera, a Celtic city which existed on the site of the modern Andover; and with this name I close a list which might be much extended, but which appears unnecessary in the present place.

I cannot, however, close this attempt to describe, in a brief narrative manner, the present state of our knowledge of the coinage of the Britanno-Celtic tribes, princes, and cities, without referring to a rude class of coins belonging to that epoch which have hitherto met with but little attention from our numismatists. I allude to the rugged coins formed of a mixture of zinc and tin, which have evidently been cast in wooden moulds, their surface showing the grain of the wood so distinctly as almost to enable a careful observer to determine its kind. The coins represented in the preceding column are of this class. The types are evidently those of the beautiful Macedonian Philips, in their lowest state of degradation; the profile of the noble head of Apollo being reduced to a few rude, though not altogether uncharacteristic, raised lines, while the main outline of the horse of the bega, all portions of the chariot, even the wheels having disappeared. The other coin has other types; on one side the Gaulish symbol of the boar is plain enough, but on the other the rude full face offers no clue to an intelligible solution of its meaning. These coins were found in making the excavation for the ornamental water in St. James's Park, and other similar coins have been found in other localities. In the isle of Thanet several have been recently found, which have been minutely described by Mr. Fairholt. It is supposed that they were struck in private mints.

H. NOEL HUMPHREYS.

POLARIZATION OF LIGHT.

MORNING folds back the purple curtain of night, and light comes tripping in from eastern skies at the rate of 192,000 miles in a second, to harbinger the rising sun, who, when eighteen degrees below the horizon, sends his first beams as an advanced guard to prepare Nature for his full glories. His beams paint the green meadows, and the gay flowers, and the luscious fruit; they waken up sleepy Nature, and rouse to activity by their potent power the thousand songsters of the grove, who, one by one, join in the joyous anthem, until it swells into a grand chorus in praise of Him who in the beginning said, "Let there be light, and there was light."

How gently, in spite of its velocity, its beams fall upon our senses, printing on that marvellous tablet, the retina, pictures that may be transferred to, and bound up in the volume of our memory, whose leaves we may often scan at our will, and see again and again in all their freshness.

What then is this light? Is it a vast series of imponderable particles ever emenating from all luminous bodies? This was the opinion entertained by Sir Isaac Newton, and on it he based the molecular theory, while Huygens held it to be a series of undulations or waves, excited in a medium pervading all space, even to the interstices between the particles of matter. This is termed the undulatory theory; each have their advocates, each have their advantages, though the latter has almost displaced the former, from the fact that by the undulations we are enabled so much better to understand and account for certain phenomena which this light presents when subjected to certain treatment. It is of course possible that each may be alike right or wrong, yet the facts remain unaltered. Dismissing the Newtonian theory, we shall consider each ray of light to consist of a series of vibrations, not less than two, performed at right angles to each other. Assuming this position as correct, we shall endeavour to place before our readers, in an intelligible form, that most complex series of phenomena implied in the term polarization of light—a term than which we know not one that implies so much and expresses so little. Confessedly, it is an unfortunate one, and has led many a young student into a maze of perplexity, until he has given up the subject as hopeless. Not that it is beyond the comprehension of the tyro, but because those who have written of it have so encumbered it with technicalities, that, like a mummy, it were almost impossible to discern a single feature. To unroll the mummy-cloth of scientific terms, and hard names, and mathematical expressions, with the hope of disclosing the features of one of the most beautiful subjects which Nature and science furnish for our study, be it our task.

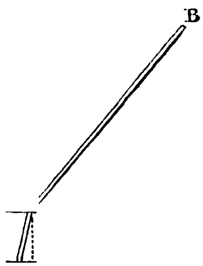


FIG. 1.

When a beam of light, admitted into a darkened room through a hole in the shutter,

falls upon a thick piece of glass, one of two things may happen, depending on the direction in which it strikes the surface: if perpendicularly, that is at right angles, then it will pass through it in a continuous line (Fig. 1, A A); if at less than a right angle, as at B, it still passes through it, though not in a continuous line; but, during its passage through the denser medium, it becomes bent back towards the perpendicular, as at C. In other words, it is refracted.

It is this principle on a gigantic scale which brings the sun's earliest beams to our eyes in the soft morning twilight, and makes them linger with us in the evening, ere all settle down into the Tyrean tints of night. It admits of easy demonstration:—If we fill a glass

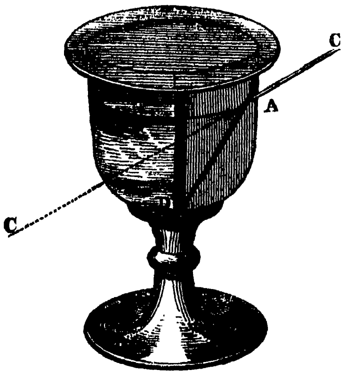


FIG. 2.

tumbler (Fig. 2) with water rendered slightly turbid by the addition of a little milk, covering the top and one of its sides with a piece of card, having a small hole (A) to admit a beam of light from a candle. An imaginary line (C) drawn from the source of light through the orifice in the card, and through the liquid, will show the course the ray would take were the vessel filled with air; and, on looking through the liquid sideway, we shall find the ray broken back just where it strikes the surface of the liquid (D); and as with water so with glass, each being denser than the air.

When a piece of glass is coated on one side with an opaque substance, as in a looking glass (Fig. 3), then the rays falling upon

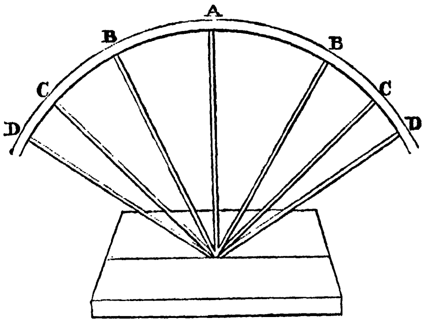


FIG. 3.

it will be reflected; the direction of that rebound depending on the direction in which they struck upon its surface. If perpendicularly, *i.e.*, at right angles (A), to be thrown back from whence it came; if at another angle, then will they be reflected at an equal angle on the opposite side of the perpendicular line, as at B B, C C, and D D.

There is a simple arrangement, which to the untutored appears miraculous, depending for its success on this law of reflection. In our early days we were accustomed to amuse our companions with it during the winter evenings; we have since seen it exhibited to a gaping crowd of unlearned rustics, in whose countenance there was portrayed mingled doubt and astonishment, when told that by it they might see round a corner. It is simply a square tube of the form shown in

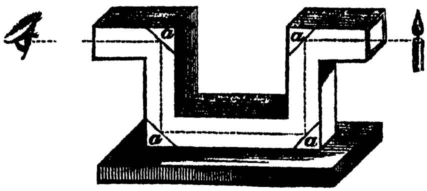


FIG. 4.

Fig. 4, having four reflectors placed at an angle of forty-five in each corner (*a a a a*).

It is easy to be seen how a taper, placed at the one end should be seen through the other.

The sensation called light excited in our eyes by the sun is of dazzling brightness; but as it paints the rainbow's seven tints, and gives colour to all objects, it seems but natural we should infer that it must need possess these various colours in its beams.

Newton first demonstrated the truth of such a supposition, and we may readily repeat his experiment. He admitted a beam of light into a darkened room through a round hole in the shutter, and received the image on a white screen; he next interrupted its course by placing a glass prism so that the rays fell upon one of its sides. Instantly the round image vanished, and in its stead an elongated one appeared, painted in colours identical with those in the rainbow, and arranged in the same order, beginning from the lowest which was red, then orange, yellow, green, blue, indigo, violet. This is an inverted image, the rays having crossed at the opening. He then proceeded to try each beam separately, by making a hole in the screen that each might pass through in succession. These being received on a second prism, the orange was resolved into red and yellow, green into blue and yellow, indigo and violet into red and blue in variable proportions, red, yellow, and blue remaining unchanged; hence these were termed primary or simple colours, the other four secondary or compound colours. These results have been doubted, but need additional evidence ere we can shelve them.

We must now revert to the undulatory theory, which is too important to be dismissed with so cursory a notice as we have hitherto given it; a right understanding of it is of paramount importance in the study of polarized light. Unless we clearly comprehend the one, we may as well dismiss the other without another word; this, we think, is the great rock, the maëlstrom, on which so many have been shipwrecked in this scientific voyage. They have neglected to gain a clear appreciation of the structure of a beam of light, and the change which it is capable of undergoing; and then when the high developments have been brought before them, they have been cowed by difficulties which they themselves had assisted in rearing.

One great drawback which the student often has to labour under is the cost of apparatus. At once let us say that we mean to sweep this off the field, and give simple directions for the construction of all that is essential, at the cost of a few shillings.

When a vessel is riding at her anchor with a strong breeze blowing, she will be seen to have two motions, a pitching one from stem to stern, and a rolling one from side to side. This homely illustration will serve us to show how two vibrations may exist in one body in the same time. Now, if we refer to the figure below (Fig. 5), which we suppose to represent a beam of light, we shall see the same thing, and a section of it would show like A (Fig. 5). The undulatory

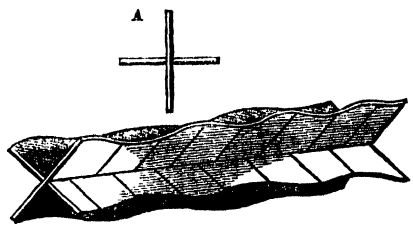


FIG. 5.

theory is based on this assumption, as before mentioned. Now mark what follows: If by any means we can make those rays neutralize each other; in other words, if we can take the ray to pieces, and lay its two waves side by side, so that the crest of the one shall fill up the hollows of the other, then we shall produce the seeming anomaly of darkness by two rays of light. We will construct a little apparatus which will show more clearly what we mean; just stating that we can do with these waves as we desire, laying them side

by side. Cut a score pieces of wood one foot long, next a piece of card, in which punch twenty holes as closely together as they can be cut without breaking, and just large enough for the rods to slip through easily, at five inches from the top of each drive a pin through, on which they will rest when in the holes. Another upright at each end, to support the frame and attach it to a stand, will complete it as Fig. 6. The rods may

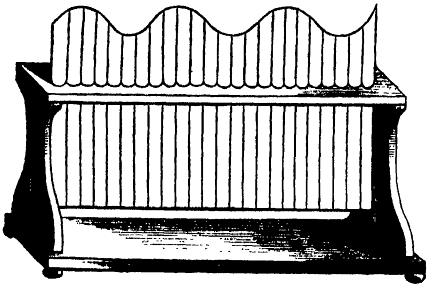


Fig. 6.

now be cut that their tops shall represent a series of waves; a piece of card (Fig. 7, *a*) may also be cut to correspond, but a few inches longer. On the card opposite every wave write the numbers one, three, five, seven, and opposite the hollows, two, four,

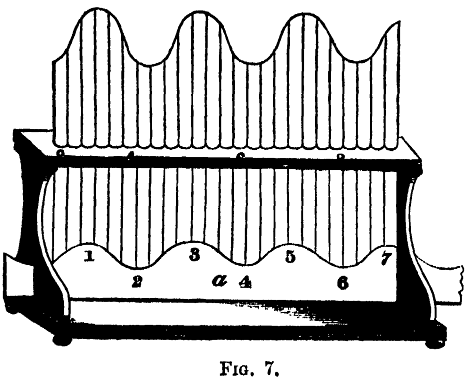


Fig. 7.

six, eight. These numbers represent respectively half undulations and whole undulations, their uses we shall learn as we proceed. If the card be pushed under the rods until the waves of the one correspond with the waves of the other, then will they be doubled in the height (Fig. 7), and this will occur at every whole undulation, when the even numbers correspond. If it be advanced half an undulation, and the odd numbers are against the even, then the tops of the rods will present a straight line (Fig. 8), the

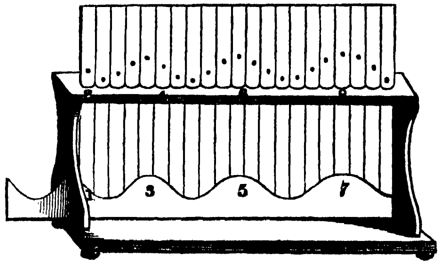


Fig. 8.

vibrations having neutralized each other by interference. Well, it is just as easily to do this with the two vibrations of a ray of light, and which we shall do ere we have finished our experiment. This is called the law of interference, which explains a series of phenomena which Newton also disclosed. He placed a convex lens on a flat plate of glass, so that the two surfaces were in contact in the centre. It is easily seen that between the two there must be a stratum of air gradually increasing in thickness from the centre. Repeating this experiment we may see what he saw. If examined with a magnifying glass, a good light falling upon the object, in the centre a black spot may be detected (Fig. 9), while every thickness of the plate of air shows a different colour, commencing with violet from the thinnest, and finishing with red at the thickest. Simple in itself, in Newton's hands, with his genius, it led to surprising results, enabling him to ascertain the exact thickness a stratum of air must be to reflect a certain colour.* This

* Our atmosphere furnishes a ready example, as it reflects a blue colour; hence the so-called blue ethereal sky.

thickness was afterwards proved to be the measure of one of the vibrations of a ray of the particular colour, which for violet is 167 10-millionths of an inch, and for red 266 10-millionths of an inch. Further, he found that by viewing these rings in the colours of the spectrum until it showed but one tint, that then the circle of black in the centre was surrounded by, say, a circle of red, then one of black, then red again, next black, etc. These will just correspond with our rods, and odd numbers producing darkness, and the even numbers producing a wave of double brightness. But for the undulatory theory we should be unable to explain these appearances.

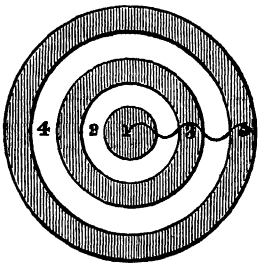


FIG. 9.

If the preceding considerations have been rightly comprehended, we shall have advanced well on the road for understanding the phenomena of polarized light, to which we will now address our remarks. It may be we *have* a difficult subject to render in a popular form; and hour after hour have we churned our own brains in years gone by, to find some golden key that would unlock the mystery hidden beneath the thick layer of scientific terms with which the subject is usually enveloped. We have found it, and, having surmounted the difficulties, offer our services as pioneers to smooth the way for our younger readers, that they may learn the mysteries of this mysterious principle called light, when in a state of polarization.

Accident led Malus, a French engineer, to the discovery. He was watching, through a doubly refracting prism, the rays of the setting sun as they fell upon a French window, which was partially opened.

We have stated that when a beam of light falls upon a bright surface, it will be reflected again at an equal but opposite angle. But that is not all. When it falls upon a glass surface at an angle of 56 or 57, as in Fig. 10, it is not only reflected, but that which is reflected has undergone a great change, so that it no longer comports itself as it did before it was reflected at this particular angle, or as it would have done, had it been reflected at any other angle. Let us see what these changes are. First, its intensity is diminished one-half; hence it follows that only one-half of the beam has rebounded from the glass to our eye, so that if the source of light was equal to twelve candles, then that which will enter our eye after the reflection will be only equal to that of six candles, or a little less. What then has become of the other six? They must have entered the glass, and have stopped there, or have passed through. Again our ray of light (Fig. 5, A) showed two waves crossing each other at right angles. In the case before us there has not passed into the glass a *part* of each of these waves, but the whole of one set, while the other has been thrown off again to our eye, as the next figure (Fig. 10) will illustrate, in which A B is the

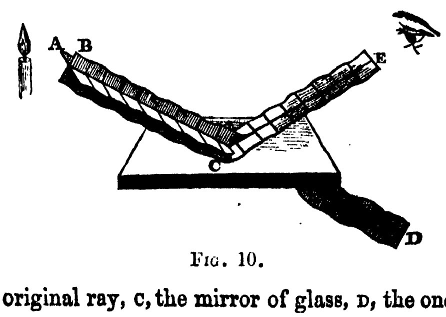


FIG. 10.

original ray, C, the mirror of glass, D, the one

wave which has passed through, and which is the upright wave; E is the horizontal wave which is reflected to the eye, and is a beam or wave of polarized light.

Simply, then, a beam of polarized light has only one set of vibrations—a ray of common light has two sets of vibrations, crossing each other at right angles. The difference is too evident to need further comment.

By a series of reflections from bright metal plates we can alter the position of the two waves, making the incline less and less to each other, until they be brought side by side. In this case, again, it will be seen that the ray which reaches our eye after the last reflection will be a polarized ray; just, or nearly as bright as the source from whence it came. This process implies an arrangement of reflectors too complex to be of use for ordinary purposes. It is therefore not resorted to, except as an experiment. The method usually adopted to bring about this change, and which perhaps is the most perfect, is that of allowing a beam of light to

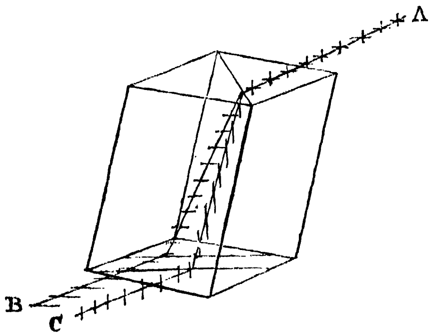


FIG. 11.

fall upon a polished crystal of Iceland spar, in the direction shown in Fig. 11. We should expect, from what we have learned of refraction through glass, that the ray would suffer the same change in passing through the crystal, which it does, but more. It has become split up into two rays, during its passage through the crystal of carbonate of lime, and emerges from it to produce two images of the source of light, B C. Again, if we look at the figure, we shall see that these two rays are the two sets of waves separated, the horizontal one having been bent to one side, as well as both being bent back. Each of these are polarized beams, each having only one set of vibrations.

The wave C is termed the ordinary; B, the extraordinary rays. The cost of these crystals precludes their general use. They are luxuries which the student is not always able to obtain; most fortunately they are not indispensable.

The discovery of Malus and the genius of M. Biot have placed us in a position to make for ourselves, at the cost of a few pence, a most efficient polarizer. A neat little instrument is made by Bestall, and sold for a few shillings, which answers the purpose very well; but the inconveniences attending its use have led us to modify its form, which we present to our readers, with such a description of it as shall enable any one with an ordinary facility for construction to make one for themselves.

The body (A A, Fig. 12) is made of gutta-percha, or of zinc, is three inches diameter, and four inches long to the inner angle, B, where the tubes are joined. If made in gutta-percha it must be one-eighth of an inch thick, and slightly warmed and bent round a wood cylinder. The joints may be easily made with a piece of hot iron. Each tube must be inclined to the other at the angle shown in the drawing, the lines of which may be projected to any length, and will then serve as a correct guide. Over one end is fitted a ring, three-quarters of an inch wide, to which is fastened a piece of ground glass, C; its use is to diffuse the light. The stage is of the same material, four inches square, made of two plates, half an inch apart, joined at two sides, with two slits, O O, on either side, through which to pass an elastic ring to hold

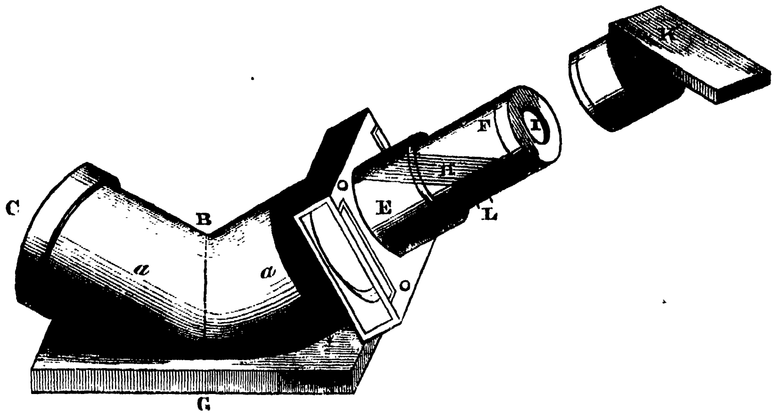


FIG. 12.

the object steady. Each plate has a circular opening, nearly as large as the body to which they are fitted by a ring attached to the under one. The upper plate has also a ring, E, two and a quarter inches internal diameter, and two inches long. A third tube, F, must be fitted to E, that it may turn freely in it. This may have a half-inch hole cut in it at Z, to be opened at pleasure.

From the lower part of the body we may now cut a piece, three and a-half inches long, directly in the position shown. This will form a base for it to stand on the polarizer, G, to which it may be fastened. The polarizer is made of three pieces of flat sheet-glass, five inches by four, laid one on the other and bound at their edges with paper, or aught else that may better suit the taste of the maker.

The under surface of the middle plate must be coated with black varnish, ordinary Brunswick black answers very well and dries quickly. H is a bundle of eight pieces of crown glass, three inches long, one and three-quarter inches wide. These may be held together by pasting a slip of thin paper on the edges, and should be placed in the tube at the angle shown, which is 56° or 57° nearly.

The cap, I, carries an ordinary magnifying lens of three inches focus. We may further make an additional ring, fitting the outside of E, to carry another bundle, as in K. All this being accomplished, we are in possession of an instrument which will enable us to repeat every experiment with polarized light, if we except a few of the more complex, which would require a slight modification, and which, if our space permit, we will notice ere we close.

Arranging our polariscope before a lamp, that the rays may pass through the ground glass, and fall on the polarizer G, we shall see polarized light on looking through the lens E, the bundle of glass, H, being removed. Now let us propose a question for solution—Why is this light which we now see called polarized light? Because it possesses different properties on different sides, and is supposed to be like the poles of a magnet, whence the term polarization. Let us try if we can discover what these properties are. A ray of common light may be reflected in any and every direction as often as we please, in whatever position the reflectors may be placed, so that it can strike the surface. We will test our light by a second reflector K, slipping it over the tube E, and placing our eye opposite it at an angle of 56°—that being the angle at which the light will strike it as it passes up the tube.

When K—which we shall call the analyzer, because it ascertains its properties, etc.—is placed in the same position as G, so that a line drawn along the surface of each would be parallel, as they are in Fig. 13, we shall see a bright light, because it is reflected from the surface of our analyzer; but if we turn

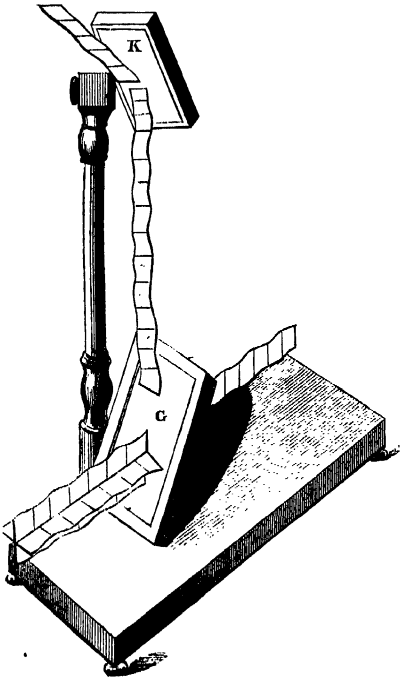


FIG. 13.

K round a quarter of a circle, we shall no longer see the light reflected from it, as it will now pass through it. Turning it another quarter, it will be again reflected, because again in the same plane as G (Fig. 15). If turned round another quarter, the image will disappear, because now the reflectors are at right angles to each other. We see then that there are two sides on which the ray can be reflected, and two on which it refuses to be reflected. These are the different properties, or the different sides, which the beam of polarized ray possesses, and which common light does not possess.

Figs. 13, 14, 15, 16, show these positions of the polarizer and analyzer, and will help us to explain why the effects are produced.

Fig. 13 exhibits the polarizer, G, and

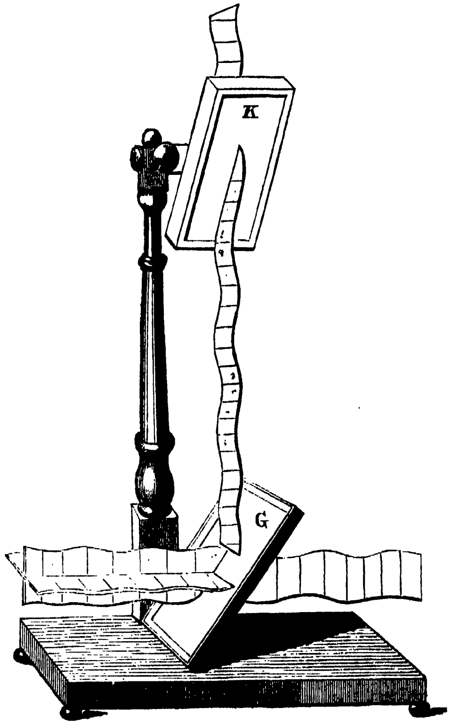


FIG. 14.

analyzer, K; the crosses are the two vibrations of a ray of common light falling on G, the perpendicular ones passing through, or being absorbed by its black surface. The horizontal waves are reflected to K, and from it again reflected to the eye; K G being both in the same plane.

Fig. 14 shows K turned a quarter round, and the horizontal wave passing through it, and not reflected.

Fig. 15, K is turned another quarter, when the horizontal wave is once more reflected.

And in Fig. 16, K being turned another

quarter, the horizontal waves are once more not reflected but pass through, or are absorbed by its having a blackened surface.

There is a pleasing variation of this experiment which is instructive, and illustrates the polarizing properties of water. If when our analyzer is turned round that it may be at right angles to the polarizer, and the light is invisible, we gently breathe on the surface of K, we shall recover the luminous rays, because water does not polarize at the same angle as glass, but at an angle of 52°. Therefore our analyzer ought to have been set at 52°, that none of the light should have been reflected. As it is it has the power of reflecting a portion, which power it will lose as the moisture evaporates.

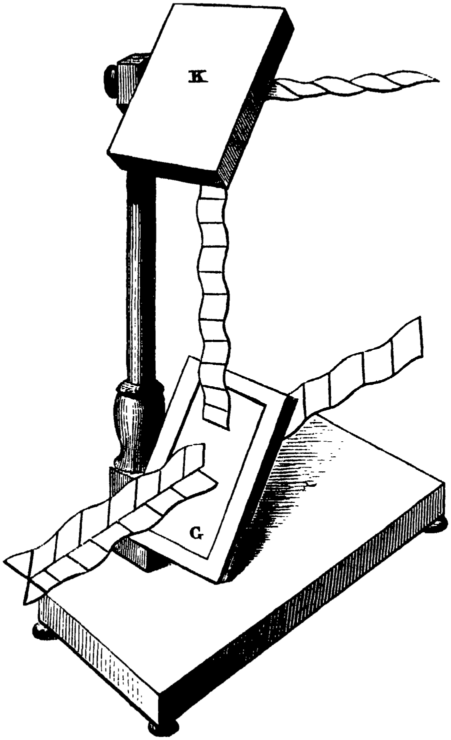


FIG. 15.

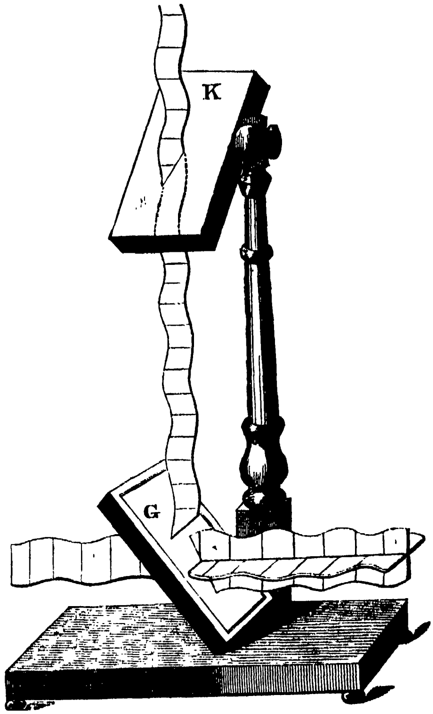


FIG. 16.

It may be well that we take a hasty glance at another arrangement for the polarization of light by absorption. Here there are used two thin plates of tourmaline, a mineral which occurs in crystals of a light blue colour, and sometimes of a neutral tint. The latter is considered the most valuable, as thin plates cut from it possess the power, in a marked degree, of absorbing one of the vibrations of a ray of light. The one which passes through it depends upon the position in which the crystal is held. All crystals have an imaginary line or direction which is termed their axis, and the vibration which is performed in a line with this axis passes through, while that which is at right angles to it is stopped and absorbed by the tourmaline.

Fig. 17 shows a pair of these plates, and the lines drawn from end to end show the

direction of the axis. The crosses represent a beam of common light. The marks at A show one set of waves which have passed through, and which it is clear must be a wave

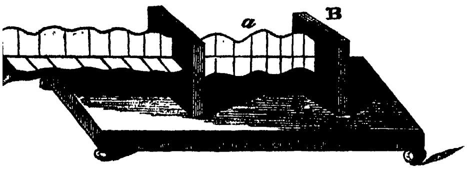


FIG. 17.

of polarized light. It is further found that this wave will not pass through another crystal if placed in the position shown at B, because the axis of the second plate is at right angles to the wave. Therefore it is absorbed, and on looking through B we shall have darkness.

We have succeeded in making Herepath's Artificial Tourmalines, which work admirably, but they cost so much care and trouble in their preparation that it is best to expend a few shillings in the purchase of one. If it be substituted for our bundle analyzer, mounting it on the end of a short tube that will fit the ring so that it can be rotated, adding also a pair of plano-convex lenses, or even one of two-inch focus, it will make our polariscope as good and efficient as though we had expended pounds in its construction.

Hitherto we have dealt with polarized light in the abstract; dry and dusty detail have beset our steps and presented themselves at every turn. Yet we hope our words have not been without their import, nor our teaching without profit. Our pictures have been in chiaro-oscuro, henceforth they will be painted in tints so beautiful that they will gain a speedy favouritism. The lovely bow set in the heaven, as the seal of the Creator's promise, shows no tint more fair than those which polarized light will paint for us.

It would be strange, if, with these new properties which light has developed at our hands, it did not present other objects in a new phase when subjected to its action. It will not disappoint us if we place on the stage of our polariscope a thin plate of selenite, or, as chemists term it, crystallized sulphate of lime. Allowing a beam of polarized light to pass through it in certain directions, it presents to our eye at least two colours when we rotate the analyzer. If its thickness be uniform it will show a uniform tint of red, yellow, or blue in one position, and of green, violet, and orange in another, and these will be repeated alternately at each quarter revolution of the analyzer. If the thickness of the plate vary, then shall we have several colours, but they will still alternate during the revolutions of the analyzer. Selenite is a doubly refracting crystal; upon this depends its power of manifesting these tints. True, it does not sufficiently separate the beam to show two images; nor has it two waves to separate. How then can it divide them?

The single wave of polarized light in its passage through the selenite undergoes a change. Part of it is turned round, so that it has again acquired two sets of vibrations. It is now said to be dipolarized. One set of waves is retarded in their course, and made to travel a longer distance by being turned aside, so that they cannot arrive at the same moment as those that have passed directly through. Therefore their waves may interfere and produce colour.

This dipolarized ray now behaves as common light, inasmuch as one set of waves will pass through our bundle analyzer, while the other set are reflected.

A reference to Fig. 18 will show how this occurs. A is the beam of common light; B, the polarizer; C, the polarized ray; D, the selenite, with lines drawn upon it showing its two axes; E, the ray, split into two rays or dipolarized; F, the analyzer; G, the perpendicular wave, which passing through it shows a green colour, from the waves of

yellow and blue meeting at equal undulations, while the red waves of the same ray interfering with each other are lost; R, the

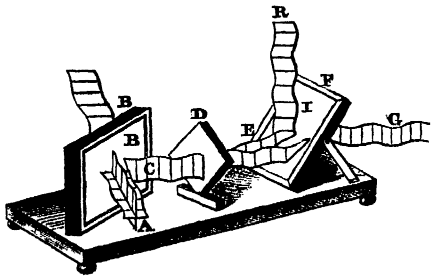


FIG. 18.

horizontal wave of red rays is reflected, and shows a spot of red light, while the yellow and blue of the same wave having interfered are lost.

When the analyzer, F, is turned round a quarter of a circle, then the red rays, R, pass through showing red light; while the yellow and blue of the same ray having in-

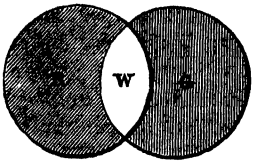


FIG. 19.

FIG. 20.

terfered are lost, and G the yellow and blue rays of the other wave are reflected and show green light, while the red waves are lost from interference. We might have taken any other colours than these, but being three simple colours they are better adapted for illustration than the other four which are compounds of them. It appears that green and red have a particular relation the one to the other. They are termed complementary because the one is just the complement required by the other to make white light. With the means at our command—a double-image prism—we could not only show both spots of colour at one time, but cause them to overlap as in Fig. 19, when we should have white in that part where they are superposed. Approximately we can do it by fastening a bright green and bright red wafer on a black card, with a space of two and a-half inches between them, looking at them through a stereoscope. The two images being made to overlay each other, a dingy white spot will be seen. Were the colours perfect the white would be perfect too.

From plates of selenite, which may be cut to any thickness with a thin knife, we can with a little ingenuity construct several pretty designs for illustrating our subject. If we cement a plate of it to a slip of glass and carefully grind out a concave cavity, using a marble with fine emery and water until the centre be reduced to the most extreme thinness; when covered with Canada balsam and a thin piece of glass, and placed in the instrument, consequent upon its varied and regularly increasing thickness, it will show a series of rings of colour, the centre being violet, then all the other colours of the spectrum in their order. We can by a modification of this treatment produce a monogram like Fig. 20, showing the letters in red and green, changing to green and red as the analyzer is rotated. The most ready means to accomplish it are, first, to make the design in paper and attach it to the under side of a slip of glass which has cemented on it a plate of selenite. By means of a graver the first letter must be cut out to a certain depth as regularly as possible, and then the other at a different depth. Other designs will suggest themselves, each illustrating the laws of interference as regulated by the thickness of the plate through which the polarized ray passes, and by which one slice of it is retarded, such as stars with rays of different colours, a heart's-ease, Gothic window, etc.

In concluding our article we may profitably and briefly review the application of

polarized light to the discrimination of substances whose differences of structure are so slight that even with the highest magnifying power our eyes fail to appreciate them. To those who possess an achromatic microscope, it opens up a wide field of beautiful research, and such will be pleased to know that for a few shillings they may now obtain or make for themselves a most efficient polarizing apparatus, that will do them no discredit, or detract one whit from the beauty of the appearance which their objects will present under a half-inch power.

A piece of blackened glass laid upon the plane mirror will effectually polarize the light if it fall upon it at the proper angle —56·45; or it may be effected by transmission through a bundle of sixteen squares of thin microscopic glass, made as before directed and fitted into a tube, to be attached to the plate which usually carries the diaphragm. As an analyzer an artificial Tourmaline is unexceptional. It should be attached with a little gum to the shade of the eye-piece, and will give a large field, is convenient for rotation, and exhibits the brightest tints that can be desired. It is equally applicable to the dissecting microscope. An abundance of objects may be gleaned from the animal, vegetable, and mineral kingdoms, some of which will exhibit their colour with the selenite. These are doubly refracting. Others without the polarizer, they themselves filling the office by stopping one of the vibrations. Of this class are crystals of iodo-sulphate of quinine, etc.

My hirsute brother, if you have ever laid a razor on your chin, then have you cut away at every stroke of the relentless blade, a thousand beautiful objects. Save the next portion, free them from soap by washing in water, then add a little ether to remove the grease; after this a little turpentine to make them take the balsam readily, and they will repay you for your trouble when submitted to the polarized rays.

You, my fair sister, in your botanical rambles, when searching for the graceful fern, will find their stems covered with scales, which being soaked in turpentine, and mounted in balsam, will be equally beautiful. Your laundry and store-room will furnish grains of sago, wheat, potato, and arrow-root—starches; and, alas! your cocoa will be equally prolific, especially if it pass for dietetic. We must not omit the starch of tous-le-mois, the most beautiful of all, whose form we figure (Fig. 21) as an illustration of the

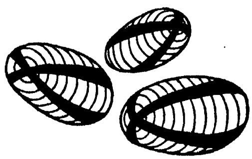


Fig. 21.

whole. Each has particular and distinctive features, but in all will be seen the bands of colour, alternating with and displacing each other in their rotation, as the analyzer is turned round. Even a thin slice of your whalebone cut across the fibres, after being softened in boiling water, is no mean object when carefully mounted in balsam; while a strip from the tube of your goose quill—if you still use that graceful instrument in penning your messages of mercy—will with similar treatment show the most beautiful tints. We are warned that we have already exceeded our limits, and must close our lists. We do this with the hope that we have elucidated our subject without prolixity, clearing away the difficulties which beset it, without a sacrifice of scientific truth, showing at the same time that in the higher branches of natural science there are materials which, if rightly arranged, may furnish the most delightful subjects for Recreative Science.

Hull. Thomas Rowney.

SEA-WEEDS.

There are few things in Nature more beautiful or attractive to the mere casual observer, and more full of varied interest to the scientific inquirer, than a well furnished tidal pool on a rocky sea-shore. It contains a wonderful variety of animal life, for we may often, in the space of a few square feet, find numerous examples of all the four great sub-kingdoms—vertebrata, articulata, mollusca, radiata; and if the creatures of the lower orders be, as is often the case, more attractive as regards the brilliance of their colour, and the exquisite symmetry of their forms, those of higher grade are doubly interesting by reason of their wonderful habits and instincts, and their complex organization.

But it is the vegetable life of the pool that I wish to bring before the reader's notice. Surely

"Earth hath not anything to show more fair"

than is that luxuriant blending of richest russet, tender green, and glowing crimson, with which the rock is everywhere fringed and carpeted. Some species, too, show a beautiful iridescence, flashing back rainbow colours with every motion of the water. This may be seen, to some extent, in the common Irish moss (*Chondrus crispus*) and in *Nitophyllum laceratum*, but is much more vivid in *Cystoseira ericoides*, a species unknown in the north, but tolerably common on the south coast of England. Dr. Harvey says: "When growing under water, it appears clothed with the richest tints of blue and green, more like those phosphorescent gleams that flash from the lower animals than any vegetable colours. As each twig waves to and fro in the water the hues vary, and sometimes when the light falls partially on a branch, some portions seem covered with sky-blue flowers, while others remain dark. All these beautiful tints perish when the plant is removed from the water." Many of the red Algæ lose their colour rapidly as decay commences. The beautiful mottled aspect which *Plocamium coccineum* so frequently assumes when washed up on the beach is due to this cause, and *Gelidium cartilagineum*, a foreign species, often presents during decay "the most splendid gradation of colour in a single specimen, from dull purplish pink (its original dye), through scarlet, orange, yellow, and verdigris green to white, to which colour all the red and green species may be bleached after long exposure." Some of our native species (*Desmarestiæ*, etc.) have the peculiar property, not only of rapidly decomposing and changing colour themselves when removed from sea-water, but of inducing a similar speedy putrefactive change in others, so that it is necessary for the collector to keep them separate, and, if possible, in salt-water, until they can be laid out and dried.

The greatest variety of vegetation is generally to be found about half-tide level. Near high-water mark the Algæ are, with some few exceptions, almost exclusively green, while further seaward the green species become scarce, giving place to the Laminariæ and such of the red weeds as are capable of bearing a considerable degree of exposure to light. The sea is divided by naturalists into zones of depth as follows:—First, the *littoral* zone, which includes the whole expanse of rock or sand between tide marks; second, the *laminarian* zone, extending from low-water mark to a depth of about twelve fathoms; third, the *coralline* zone, from twelve to thirty fathoms; and lastly, the region of deep water. All these divisions are subject to much variety in extent of surface; the littoral zone especially being on some shores many miles in breadth,

while on very precipitous, rocky coasts it may be marked only by the height of rise and fall of the tide on the face of the perpendicular rock. Yet even in this case the characteristic vegetation of each zone will often be found strikingly developed, and forming distinct bands of varied colour. As a general rule, the green Algæ may be said to frequent the upper half of the littoral zone, while the red species inhabit the laminarian and lower half of the littoral zone; the brown series being found, to a variable extent, in all situations. Some species are excessively exclusive in their choice of habitat, as, for instance, *Fucus canaliculatus*, which is never found except near high-water mark, where on many coasts it occurs abundantly, forming a narrow belt upon rocks and stones. The brown Algæ, though forming so large a proportion of the *bulk* of sea-weeds all the world over, are comparatively few as to number of species. They are, however, by far the most directly useful to man. We were at one time altogether dependent on them for the supply of soda, and are still so for iodine, a substance which is now almost a *sine qua non* both to the physician and the photographer. Neither should we omit to notice the value of these weeds as a manure. So important is this application of them considered in the Channel Islands, that the gathering of the "vraick" crop is regulated by legal enactment. Sea-weeds are now but little used as an article of diet in this country, though the "Irish moss" is sold in the shops, mostly as a food for cattle, and a preparation of *Porphyra laciniata*, called "laver," is still considered by some epicures as a great delicacy.

We have stated that the red Algæ are mostly denizens of deep water, beyond ordinary low-tide mark; but although they attain the greatest perfection in such situations, many of the more robust species are common in rock pools, even as far as the extreme of high-water. These vary remarkably in appearance, according to the place of growth; *Chondrus crispus*, for instance, being, when well covered, of a deep purple colour, but when growing in shallow pools, exposed for hours together to a strong sunlight, often assuming a bright grass-green, its gradations between these two extremes being innumerable. *Ceramium rubrum*, in like manner, passes through almost all shades of colour from a deep vinous red to a yellowish green or dirty white tint, these last tints being generally observed in ill-developed plants near high-water mark. The more delicate species of all these families must be sought for in the most obscure corners and crevices of deep pools near the verge of low-water, where they hide under the shade of larger weeds. So often, in the material as well as in the moral world, does

> "True beauty dwell in deep retreats,
> Whose veil is unremoved,"

except by loving and unwearied search.

Not only are sea-weeds beautiful on the sea-shore and when laid out on paper; among them may be found some of the most beautiful of microscopical objects, while their transparency and simple structure admirably adapt them for the exhibition of many of the elementary processes of plant life. On this account they have always been favourite objects of investigation with the vegetable physiologist, and to this part of their history we may possibly, on some future occasion, return. The marine Algæ, however, contain, so far as we know, no examples of perfect unicellular plants, such as *Protococcus*, *Chlorosphæra*, etc., among the fresh-water species. The *Oscillatoriæ* are, probably, the lowest of marine species, and certainly not the least interesting. Their motions have been described, from fresh-water specimens, in a former number of Recreative Science, by Mr. Tuffen

West. Even in the movements of these minute organisms there is a certain sublimity; their motions are so steady and resolute, strangely contrasting with the vacillating, uncertain progress of the *Diatomaceæ*. We may often see a single filament, entangled and firmly entwined by two or three others, deliberately work itself free, and pursue steadily and unswervingly the path—always straight ahead—which one might fancy it had previously marked out for itself. This constant onward movement easily explains the speedy covering of large surfaces of ground by these minute organisms, and seen in actual progress under the microscope, it reminds one strongly that by steady effort only can we accomplish great ends—

> "How dull it is to pause, to make an end,
> To rust unburnished, not to shine in use!"

and that if with Ulysses we would do

> "Something ere the end,
> Some work of noble note,"

we must also with him be

> "Strong in will
> To strive and not to yield."

GEORGE S. BRADY.

ASTRONOMICAL OBSERVATIONS FOR AUGUST, 1861.

THE Sun is in Leo until the 23rd, when he passes into Virgo. He rises in London on the 1st at 4h. 25m., on the 10th at 4h. 38m., on the 20th at 4h. 54m., and on the 30th at 5h. 10m.; setting on the 1st at 7h. 46m., on the 10th at 7h. 31m., on the 20th at 7h. 11m., and on the 30th at 6h. 50m. He is above the horizon in London on the 1st, 15h. 21m., and on the 31st, 13h. 35m.

He rises in Edinburgh on the 4th at 4h. 12m., and on the 30th at 5h. 2m.; setting on the 5th at 7h. 57m., and on the 30th at 6h. 55m.

He rises at Dublin on the 2nd at 4h. 19m., and on the 18th at 4h. 45m.; setting on the 3rd at 7h. 49m., and on the 19th at 7h. 18m.

The Sun is on the meridian on the 1st at 12h. 6m. 1s.; on the 15th at 12h. 4m. 14s., on the 31st at 12h. 0m. 7s.

The equation of time is on the 1st, 6m. 1s., on the 15th, 4m. 14s., and on the 31st, 7s. subtractive.

The Moon is new on the 6th at 12h. 54m. p.m.

Full Moon on the 20th at 11h. 51m. a.m.

She is nearest to the earth on the 10th, and farthest removed on the 26th.

Mercury is at the beginning of the month in the constellation of Cancer, and in Leo at the end. He reaches his greatest western elongation on the morning of the 11th, when he is best situated for observation. He rises on the 4th at 3h. 14m. a.m., on the 14th at 3h. 4m., and on the 24th at 3h. 52m. a.m.; setting on the 4th at 6h. 38m., on the 14th at 6h. 38m., and on the 29th at 6h. 51m. p.m. Diameter on the 1st, 9s., and on the 25th, 5s.

Venus is in Virgo. On the 8th she is within 20m. of Saturn at 6h. a.m.; on the 21st, 4m. east of β Virginis at 8. 16m. p.m., and on the 26th, 5m. west of η Virginis at 1h. 56m. p.m. On these occasions both objects are visible in the same field of the telescope. She rises on the 4th at 6h. 38m., and on the 29th at 7h. 56m. a.m.; setting on the 4th at 8h. 36m. p.m., and on the 29th at 7h. 44m. p.m. Diameter on the 1st, 10½s., and on the 25th, 11½s.

Mars is in Leo, and invisible, being in conjunction with the Sun on the 27th. His diameter is only 3s.

Jupiter is also in Leo, and invisible, being in conjunction with the Sun on the 31st. His diameter is 29s.

Saturn is also in Leo; setting on the 4th at 8h. 47m. p.m., and on the 29th at 7h. 14m. p.m., and rising after the Sun. He is scarcely visible.

Uranus is in Taurus, rising on the 4th at 11h. 51m. p.m., and on the 29th at 10h. 16m. p.m., setting on the 4th at 4h. 15m. p.m., and on the 29th at 2h. 40m. p.m.

Eclipses of Jupiter's Satellites.—Owing to the nearness of the planet to the Sun, there are no observable eclipses during the month.

Occultations of Stars by the Moon.—No occultations of stars larger than the 6th magnitude occur during the month.

The variable star Algol reaches its least light in the evening on the 12th at 11h. 33m., and again on the 15th, at 8h. 22m.

The variable star Mira Ceti arrives at its maximum light on the 6th, when it rises at 11h. 25m. p.m. The variations of this singular star are slow and irregular; the period extending over eleven months, during which it is invisible to the naked eye for seven months.

Meteors.—The August epoch is on 9th and 10th.

Stars on the Meridian.—On the 2nd, α Ophiuchi souths at 8h. 42m. 52s. p.m. On the 4th, α Aquilæ souths at 10h. 50m. 9s. p.m. On the 4th, Fomalhaut souths at 1h. 59m. 38s. a.m. On the 8th, α Lyræ souths at 9 h. 22m. 51s. p.m. On the 12th, β Lyræ souths at 9h. 19m. 48s. p.m. On the 14th, δ Aquilæ souths at 9h. 38m. 18s. p.m. On the 14th, α Aquilæ souths at 10h. 10m. 50s. p.m. On the 14th, Fomalhaut souths at 1h. 20m. 14s. a.m. On the 18th, β Aquilæ souths at 10h. 7m. 27s. p.m. On the 19th, α

Capricorni souths at 10h. 17m. 27s. p.m. On the 19th, α Aquilæ souths at 9h. 51m. 11s. p.m. On the 20th, α Cygni souths at 10h. 39m. 47s. p.m. On the 22nd, β Aquarii souths at 10h. 19m. 21s. p.m. On the 23rd, ϵ Pegasi souths at 11h. 28m. 30s. p.m. On the 29th, α Aquilæ souths at 9h. 11m. 51s. p.m. On the 29th, Fomalhaut souths at 13h. 21m. 15s. a.m. On the 31st, α Aquarii souths at 11h. 18m. 17s. p.m.

E. J. LOWE.

METEOROLOGY OF AUGUST.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	ela[illegible] force …our, or the p… due to the w… …aine…	Mean pressure … air, or the pr… due to the ga… the air.	M… weight of … cubic foot	Mean degree of hu… dity 100 = compl… saturation.	Mea… …ntity of … in …rtical co… of atmosph…	… of a c… of air.
	Of an inch.	Inches.	Grs.		Inches.	Grs.
1848	0·397	29·304	4·5	0·82	5·5	528
1849	0·460	29·371	4·7	0·87	6·4	525
1850	0·428	29·342	4·9	0·88	5·9	527
1851	0·424	29·485	4·8	0·81	5·9	527
1852	0·433	29·208	4·9	0·80	6·0	522
1853	0·379	29·495	4·3	0·79	5·2	530
1854	0·418	29·434	4·7	0·82	5·8	527
1855	0·455	29·354	5·1	0·85	6·3	525
1856	0·430	29·288	4·8	0·76	5·9	526
1857	0·465	29·378	5·1	0·80	6·4	527
1858	0·370	29·420	4·1	0·67	5·1	528
1859	0·439	29·335	4·9	0·79	6·1	527
1860	0·355	29·119	4·0	0·78	4·9	528
Mean	0·420	29·349	4·7	0.80	5·8	527

The mean elastic force of vapour, *i. e.*, the pressure of the barometer due to the water contained in the air, is for August of the last thirteen years 0·420 of an inch (or rather over four-tenths of an inch). Ranging between 0·355 of an inch in 1860, and 0·465 of an inch in 1857—a difference of 0·110 of an inch (or over a tenth of an inch).

The mean pressure of dry air, or the pressure due to the gases of the atmosphere at the height of 174 feet above the mean sea-level is for August of the last thirteen years, 29·349 inches, ranging between 29·119 inches in 1860, and 29·495 inches in 1853—a difference of 0·376 of an inch.

The mean weight of vapour in a cubic foot of air for August, during the past thirteen years, is 4·7 grains, ranging between 4 grains in 1860, and 5·1 grains in 1855 and 1857—a difference of 1·1 grains.

The mean degree of humidity (complete saturation being represented by 1·00) for August during the past thirteen years is 0·80°, ranging between 0·67° in 1858, and 0·88° in 1850—a difference of 0·21°. The mean whole amount of water in a vertical column of the atmosphere for August of the last thirteen years is 5·8 inches, ranging between 4·9 inches in 1860, and 6·4 inches in 1849 and 1857—a difference of 1·5 inches (or an inch and a-half).

The mean weight of a cubic foot of air for August, during the past thirteen years, is 527 grains, ranging between 522 grains in 1852, and 530 grains in 1853—a difference of 8 grains.

E. J. LOWE.

THE MICROSCOPIC OBSERVER. AUGUST.

ROTATORIA.—In a recent search for *Limnias ceratophylli*, we observed a more than ordinary abundance of *rotatoria*, not only of the commoner, but of the rarer species, the production of which we associated with the abundance of warm rains during the month of July. Many observers have complained of a difficulty in making a good take of wheel animalcules, and have expressed surprise at their utter disappearance from places where they were plentiful last year. Those in want of this class of objects have now, we believe, an unusually good opportunity before them, as *Rotatoria* abound, not only in new positions, but even in many old ones, which is a somewhat rare occurrence. It should be understood that as a rule the rarer species of animalcules are not usually found in the same pools during two successive years. This is especially the case with *Rotatoria* and *Desmidiæ*. In places where the search has never yet been rewarded, the search should be made again, and there is the greater probability of success than in places which have previously proved productive. The simplest method of taking *Rotatoria* is to collect a quantity of the humbler kinds of vegetation, and fill the jar or phial with water from the same pool. Tufts of confervæ, taken from a shallow margin of a weedy creek or pond, will be most likely to furnish a supply of specimens. A few such gatherings, when taken home, will afford a rich harvest of *Polygastrica*, *Desmidiæ*, and *Diatoms*, in addition to *Rotatoria*, and at this season of the year the majority of them will be in their most interesting states of development. When about to submit the gatherings to the microscope, first agitate the water in one of the vessels, and immediately remove the coarser parts of the vegetation, slightly rinsing them in the water while taking them out. Then quickly pour off the water through a fine muslin into another vessel. The strained water must be allowed to settle, when the animal portion of its contents will collect at the bottom along with the sediment. Use the dipping tube to remove a portion, and after holding the tube steady for a few, seconds, to allow the animals to collect at the lower part, transfer one drop to the live-box, and the result will probably be a various and most interesting collection, amongst which the *Rotatoria* will distinguish themselves by their lively actions in search of food,

and will by degrees get attached by means of their disks, or terminal joints, and will then set their wheels to work to indulge their voracious appetites. Another mode of capture is by means of a fine muslin net attached to a walking-stick or fishing-rod. This allows the smaller game to escape, but retains the large rotifers. After a few sweeps of the deeper part of the pond, the net is to be reversed over a receiver of clear water, and the animalcules are then easily removable by a little careful manipulation. To obviate the necessity of carrying home a large bulk of water, the contents of the receiver may be passed through the net, and the animalcules collected in a small phial. The rare Flosculariaus must be sought from the large aquatic herbage, and there are no plants so promising as *Ranunculus aquatalis* and *Myriophyllum spicatum*. Though the floscules are large enough to be detected with the eye, the beginner will need to use a Coddington, or other pocket lens, and if a single floscule is discovered further search may be made with the greatest certainty of success. But it is not to be supposed that ponds are the only hunting-grounds. Pure water has the repute of furnishing them almost exclusively, but there will often be as good a take made in the drainage of a farmyard as in any of the established meadow pools. Even the invalid, unable to stir from home, may make sure of specimens by removing a portion of the rotten leaves and gritty sediment from a water-spout, especially if access can be had to the wooden V-shaped "shoots" that are generally carried round the eaves of outhouses. In these there is always some amount of *débris* rich in *rotatoria*. *Rotatoria vulgaris* is the species most commonly distributed, the water collected in a flowerpot saucer will sometimes present it, and there is scarcely a water-cistern anywhere in which it may not be found. The same species is also found within the leaf-cells of *Sphagnum*, and among the branches of *Vaucheria*, in which latter position it is often associated with *Notommata Werneckii*. Damp moss from bogs, the roots of the common navelwort, where growing in wet places, tufts of lemna in clear ditches, and the stems of hornwort, water-ranunculus, and chara, will all furnish specimens of various degrees of rarity and interest. *Melicerta ringens*, described at page 45, is a member of this great section of animalcules, and a closely-allied creature is the *Limnia ceratophyllum*, or hornwort water-nymph. Unlike the *Melicerta*, this has its rotatory organ divided into two leaves only, fringed with vibrating cilia. It is inclosed in a cylindrical case, which, at first, is white and transparent, but afterwards assumes a brownish hue. The matter composing the case is glutinous, and extraneous particles often form a coating upon its smooth surface. Like others of the family, the *Limnias* can extend beyond the margin of its case, or shrink completely within it. When very young two red eye specks are discernible. The length of a full-grown specimen is one-twentieth of an inch, and that of the case one-half the size of the animalcule. *Limnia annulatus* sometimes studs the leaves of water-plants in such numbers as to clothe them with a russet-brown encrustation, and *Conochilus volvox* forms dense groups on the under sides of aquatic leaves. Generally speaking, however, the *rotatoria* are solitary in their habits, and wherever *Euglena* are abundant, some of the species may generally be found.

Crystallization.—One of the most beautiful discoveries of science is that which reveals the singular fact that when bodies pass from the liquid to the solid state, with a proper degree of slowness, they assume forms peculiar to themselves, which are often characterized by great elegance and beauty. These configurations are termed *crystallizations*, and each crystalline substance is regarded as having an original form, called the *primitive crystal;* a number of which, combining in various ways, frequently give rise to a rich assemblage of the most exquisite and symmetrical figures. The greater part of the solid bodies that compose the mineral crust of the globe are discovered in a crystallized state. This is true, for instance, of granite, which consists of crystals of quartz, feldspar, and mica; and vast hilly ranges of clay-slate are likewise constituted of a multitude of regular forms. The body before crystallization may exist in the fluid state, either from combining with a liquid, or from the action of fire. Brine is an instance of the first condition. Here the salt is thoroughly dissolved, so that a particle cannot possibly be seen; but if the solution is slowly evaporated, the salt again appears in the form of cubes. An example of the second mode of action is afforded in the case of sulphur, which, when melted and suffered to cool gradually, shoots out into crystals, which, if undisturbed, are soon blended into a compact mass. The original atoms are so inconceivably small, that not only do they escape the unaided eye, but even when it is assisted by the most powerful glasses they still elude its utmost range. Nevertheless, when, in the act of crystallization, particle begins to unite with particle, the microscope is of great utility, during the earlier stages of the process, and crystals of the richest configuration are then seen forming immediately under the eye, branching in every direction, with the most wonderful regularity and symmetry; and often bearing a striking resemblance to the most beautiful and graceful foliage, or crowding together in glittering star-like clusters. It is only those substances which crystallize rapidly whose beautiful forming figures can be seen by the microscope, and in order to render them visible, the following process is employed:—The salts are first dissolved in water until the liquid is thoroughly saturated, and then, when it is desired to view the crystallization, a drop or two of the solution is spread over a clear strip of glass, which has been previously warmed. The watery film is then placed near the focus of the object-glass of the microscope, and if the solar microscope is employed, a large image of the liquid on the glass is seen upon the screen. As soon as the fluid is sufficiently evaporated, the dissolved salt is beheld changing rapidly from the fluid to the solid state, and branching over the whole screen in crystals of the most exquisite forms; a single crystal, in certain cases, often apparently shooting the length of *six or*

eight feet in the course of half a minute. When saltpetre is dissolved in water, and a few drops thinly spread over a glass slide, crystals are beheld shooting inward from the edges of the fluid, upon the application of a gentle heat. The crystals are very transparent, and their primitive form is that of six-sided prisms. They appear under the microscope in a crystallized film. If the crystals form with great rapidity, long arrow-headed shafts are seen shooting swiftly along, and throwing out lateral spurs from one side. These lateral branches run parallel to each other, and from their sides secondary branches likewise emanate, spreading over the surface in lines of crystal network. If the process of crystallization advances with less freedom, the lateral branches are not formed; but the main shoot appears arrow-headed, with jagged sides, the sides or teeth being the rudiments of the lateral spurs. In India, saltpetre forms upon the surface of the ground in silky tufts and slender prismatic crystals: especially when the abundant rains of this tropical region are succeeded by hot weather. These delicate filaments are swept from the surface of the soil into large heaps, which are then leached like ashes, and the liquid thus obtained, after being suffered to settle, is evaporated, when the nitre remains in a crystallized form. In certain regions of India the lower part of the mud-walls of the houses becomes wet and black each morning during the dry season, from February to May; and portions of the mud crumble down into a fine powder. This dust is swept up every day, and contains about one-fifth of its weight of saltpetre. It is stated by the natives that the supply is abundant during those years when the preceding monsoon-storms have been most heavy, and the thunder and lightning that attend them unusuall frequent. The earth from which the nitre has been extracted, in a year or two becomes impregnated again, and the tendency of the soil to reproduce it causes much trouble and annoyance to the occupants of houses. Bishop Heber remarks "that the nitre can scarcely be prevented from encroaching, in a few years, on the walls and floors of all lower rooms, so as to render them unwholesome, and eventually uninhabitable." To such an extent does it prevail at Tirhoot, that it may be brushed from off the lime-walls of the houses, and other humid places, almost in *basketfuls*, every two or three days.

Flowers of Benzoin.—This substance melts when subjected to a moderate heat, and sends forth a thick, white smoke, which condenses, upon the under side of the cover of the vessel containing the melted gum, in slender and delicate crystals of benzoic acid. These are beautifully white and transparent, and emit a fragrant odour. A drop of the solution of this acid exhibits very elegant crystallizations under the microscope. Sharp crystals are first perceived forming at the edges, transparent, and without colour, which soon push forward towards the centre of the drop, in the form of running vines and beautiful tufts of mimic foliage. All consist of similar minute crystals gracefully clustered together; but while one shoots along in airy tracery, another extends laterally, and spreads its glittering branches from side to side; and in different parts of the field of view other configurations start forth, and rich tuft-like figures are seen in the central parts of the group. The largest tufts and vines appear dark to the eye from the immense number of minute crystals which are there clustered together; but amid these, under a subdued light, wreaths of exquisitely delicate foliage are seen, formed of the purest crystals, and gleaming like silver sprays. Interspersed with the rest, crystallizations in the form of crosses occur, which remind the observer of the spiculæ of sponges and zoophytes. When the acid is dissolved in alcohol, and the solution spread upon the glass, the crystallization proceeds with great swiftness, on account of the rapid evaporation of the spirit. At one moment the eye of the observer gazes upon nothing but a film of liquid, and at the next, on a sudden, at a single flash, order springs forth, and the chaotic surface is profusely studded with all the exquisite and graceful combinations which have been detailed.

Mr. Noteworthy's Corner.

The Kiwi and the Lapwing: Do they Stamp the Ground with their Feet?—In an account of the manners and habits of the kiwi (*Apteryx*), which appeared some time ago in Recreative Science, I happened to mention the lapwing or peewit, a bird with which I have been familiar since childhood. In May, 1861, Mr. Selby, of Boulogne-sur-Mer, commented in a note with great urbanity on what he deems to be my mistake respecting the presumed *stamping* of this bird for the purpose, as supposed, of bringing the worms out of their holes, in order to seize them as they make their appearance. In June, 1861, Mr. Joseph Clark, jun., notices Mr. Selby's details relative to this stamping of the lapwing, confessing that he has never seen the lapwing thus engaged, but assuring us that he has seen the blackbird after a *slight shower, not indeed stamp upon the ground, but "beat it with* the beak, *and then* watch for the disturbed worm with the head held on one side like that of a magpie peeping into a marrow-bone," repeating the process "if the worm did not presently appear." If I remember rightly, I think I stated that the habit of stamping for *worm-disturbing* was attributed to the kiwi, but that I could not observe any definite indications of this process upon the rather large mound of earth (containing worms) with which this strong-legged bird was regularly supplied, and which was so lightly piled up, and so "*pulverulent*" as to have made it manifest how the bird had been engaged during the night. *Footprints* of the bird, indeed, there were many, but all orderly and not interblended in confusion, as would have resulted from *stamping*. At the same time we do not deny that the kiwi may stamp for worms or grubs in its native fast-

nesses. To turn from the kiwi to the lapwing—not a thick and heavy-legged bird like the kiwi, but a lightly-tripping bird with slender delicate tarsi, and toes in accordance therewith: Now a shower naturally calls forth the worms, but it tends to sodden the ground, and render it anything but shaky or vibratory, such a soil is not the *campus putris* of Virgil. The unsound, shaky, vibratory plain, described in the well-known line, "Quadrupedunte *putrem* sonitu quatet ungula *campum*." The rain would have soddened it. Can such soddened ground be made to tremble by the stamping of the slender-legged lapwing? The rain, as we have said, calls forth the worms; the bird is all-expectancy and agitation, and trips rapidly round and about, restless, irregular in its paces, and eager for its prey. Such an action may, if it so please an observer, be called stamping: we admit it to be trampling, but *stamping resolutely and trampling irregularly and agitatedly*, are two different things. We have often seen lapwings kept in gardens, but never yet saw them *stamp*, "MORE JOHNSONII." We have seen hundreds and hundreds on the wild moorlands, in morasses, in ploughed fields, and along the lonely embouchure of rivers, but never have detected any *stamping* action, though we have seen them foraging for food. Will the general structure and muscular development of the thighs and haunches give this stamping power? Let the limb of a peewit be dissected, the weight, solidity, and direction of the muscles considered, let them be compared with the enormous pectoral muscles, and the wiry texture of those covering immediately the bones of the humerus and the forearm, and we shall at once see where the great force lies. (In some species the wings are armed with a long, sharp, hard, horny spur, used in combat with terrible effect.) The peewit is a bird of great powers of flight; on the ground it trips lightly, and runs along most gracefully, but for its stamping, all we can say is, that we never saw it perform such a feat. If Mr. Selby has seen the bird thus *fairly* engaged (that is, in *stamping*, not *hurriedly trampling* about), he is more fortunate than we have been, and we shall be constrained, if he assert the fact from his own knowledge, to give credence to it. But we have indicated with what ease an error may arise. Mr. Clark's account of the proceedings of the blackbird do not appear to us to bear upon the subject. That the blackbird may peg the ground with his bill, as he does the shells of the unfortunate snails (dislodging even the *Helix pomatia*), we are not inclined to deny, though we never saw the bird thus engaged, save when he had half extricated a writhing worm, and then it was to get his bill deeper into the worm-hole. —Excuse an *addendum* about the *hedgehog* and the *toad*. That the hedgehog sucks the milk from cows is a vulgar error, arising from the animal being sometimes seen creeping about the reposing beasts, either for the sake of warmth and shelter, or for that of the various insects which the cows disturb by their pressure on the ground, or attract about them. It is structurally impossible for the hedgehog to drain the udder of the cow. With respect to the poisonous nature of the *toad*, there is a shadow of truth in the popular belief. From the glands about the head, and from the pores of the skin generally, there exudes an acrid secretion. We have seen this secretion act as a rubefacient on the delicate hands of children, and our own have been slightly irritated after handling a toad for some time. On one occasion, a beautiful and spirited spaniel, of the Blenheim breed, in our possession, seized upon a huge toad, which it dislodged from under a bush in the garden. The dog almost instantly dropped the creature, and violently shook its head, evidently in considerable pain, while the foam and frothy saliva issued in great abundance from its mouth, the nose swelled up, and every action of the dog showed how severely it suffered. We sponged its mouth freely, for which it expressed its gratitude, as a dog can do, but nearly three hours elapsed before the mouth was all right again. I do not think it would rashly seize upon a toad after such a lesson of experience.—W. C. L. MARTIN.

PHŒNICIAN ANTIQUITIES.—During the past three months considerable progress has been made in exoring the ruins of the ancient cities of Phœnicia. In January, 1861, Dr. Gaillardot commenced at Saida, and M. Ernest Renan at Sour, and the operations at these places are now complete, with the exception of the excavation of the great necropolis at the former place. Remains of the Crusaders were found at both places, but none above ground of the Phœnicians. Gigantic blocks of granite, marking the limits of the ancient port of Sidon, still remain; also on the plain to the east of the site of the old city, a subterranean Sidon has been discovered. Here in 1855 the sarcophagus of Eschmanuzar, in the cavern of Apollo, was found. This is the only great inscribed Phœnician sarcophagus hitherto discovered. Portions of another have been found in the same place by M. Renan. Also in the rock caves of Sidon, some of which are anterior to the time of Alexander, sarcophagi of various forms, some of terra cotta, ornamented with garlands, have been discovered. Other remains of different epochs have been examined, and portions have been brought to Paris. Some of the sculptures, etc., resemble those of Egypt; others those of Nineveh and Persepolis. Amongst the objects found in the caverns and brought home are many articles of dress and common use, Phœnician coins, and a leaden sarcophagus of good workmanship.

CAN SERPENTS POISON EACH OTHER?—M. Guyon, a corresponding member of the Academy of Sciences, read at its meeting on July 1st a paper upon the question, "Is the Poison of Serpents Poison to Themselves?" In 1834 he had directed his attention to this subject, and then adopted the opinion of M. l'Abbe Fontana, who had previously stated that the venom of vipers was not mortal to vipers. M. Guyon resumed his researches in 1850, and has continued them to the present time. He has ascertained by experiments that the venom of vipers introduced by inoculation into other vipers does not cause death. When vipers bite other vipers or themselves, they

leave, not festering, but common wounds. The same is the case with serpents, whether they belong to the same or to different species. Those travellers who have related anything to the contrary, have either been mistaken, or have exaggerated, or told myths. It is now an established fact that the venom of vipers is not venom to themselves. This is the reason why venomous reptiles are so numerous in some parts of the globe, as they are not naturally prolific. They cannot poison each other.

THEORY OF LUSTRE.—Dove, of Berlin, states that "in every case where a surface appears lustrous, there is always a transparent or translucent reflecting stratum of minor intensity, through which we see another body. It is, therefore, externally reflected light, in combination with internally reflected or dispersed light, whose combined action produces the idea of lustre." Thus by combining in the stereoscope two projections of a pyramid, one drawn in black lines on a white ground, the other in white lines on a black ground, Dove found that the pyramid appeared lustrous, as though made of graphite (to Professor Rood it recalls rather the idea of highly-polished glass). Dove found also that a yellow and blue surface, when combined in the stereoscope, and viewed through a plate of violet glass, produced in the act of combination the idea of polished metal. This view of the nature of lustre led Professor Rood to endeavour to produce, by the stereoscopic combination of suitably-coloured substances, the individual lustre and appearance of gold, copper, brass, etc., and thereby afford the means of examining separately the components which may produce the appearances peculiar to each. Tinfoil and yellow paper gave the resemblance of gold leaf; tinfoil and orange-tinted paper gave copper lustre, etc.; and so on, with a variety of other combinations. Sir David Brewster opposes Dove's theory, and attributes the lustre not to one mass of light passing through another, but to the effort of the eyes to combine stereoscopic pictures. Professor Rood states that his own experiments confirm Dove's theory, and considers that a sufficient objection to Brewster's theory exists in the fact that we daily perceive lustre plainly with one eye alone.

THE EARTHQUAKE AT MENDOZA, SOUTH AMERICA (ON THE 20TH OF MARCH LAST).—Further particulars of this sad event, by which it is said about 10,000 persons perished, were communicated recently by Mr. C. Murray to the Geological Society. Altogether, there were eighty-five shocks in ten days. The land-wave appears to have come from the south-east. Slight shocks were felt near Buenos Ayres; none in Chile, but showers of ashes fell in the Upsallala Pass of the Cordilleras, which was completely obstructed by broken rocks and opened chasms. The pendulums moving north and south in the watchmakers' shops in Buenos Ayres (323 leagues from Mendoza) were accelerated; those moving east and west were not affected.

METEOROLOGICAL CHARTS.—Newspaper meteorological reports present no picture to the reader's mind. Students are, therefore, compelled, with much labour and skill, to mark upon maps, in a notation intelligible to themselves, the generalizations obtained. To aid them, Mr. Francis Galton, secretary to the Royal Geographical Society, with the help of Mr. William Spottiswoode, the Queen's printer, has designed, and had cast, types for printing a map which simply incorporates the newspaper data of the day. A specimen, printed by way of experiment, appears in the *Philosophical Magazine*.

MEMORANDA.—The astronomers of Germany will meet for conference at Dresden on the 20th and 21st of this present August. The principal subject for consideration will be the distribution of observations of the stars.——The British Association Meeting of 1861 will take place at Manchester on the 4th of September, under the presidency of William Fairbairn, Esq., LL.D., F.R.S., etc.——M. Niepce de St. Victor has been performing experiments to test the truth of the assertion that light will magnetize steel, and he concludes that light has no power to induce either electricity or magnetism.——In the last issue of the "Quarterly Journal of Microscopical Science," Dr. Hicks discusses the diamorphosis of *Lyngbya*, *Schizogonium*, and *Prasiola*, and their connection with the so-called *Palmellaceæ*. One of the conclusions of the learned writer is that numerous forms of microscopic vegetation classed as distinct are but different states of development of one and the same species. The relations established in this case are that the linear stage is *Lyngbya*, the early stage of collateral segmentation is *Schizogonium*, the adult stage *Prasiola*, and the gonidial growth has been classed under *Palmellaceæ*.——M. Bellicour recently received a consignment of wild silkworms from Japan, and was surprised to find that they would subsist on oak-leaves. The cocoons produced were very fine, but the quality of the silk not equal to that of the established species.——Micrometers have been constructed by the aid of photography by Mr. Clarence Morfitt, of New York. He has thus succeeded in reducing a scale of ten inches, divided into tenth parts of an inch to the length of half an inch, divided into two hundredth parts of an inch. This method of reduction promises to be the most simple and economical hitherto devised.——M. Seguin recently informed the French Academy of Sciences that he had once more inclosed some frogs, lizards, and snakes in blocks of plaster, and buried them in his garden at Fontenay. The day, hour, and place are indicated in a note which the Academy will keep sealed in its archives till the members shall think proper to order the blocks to be exhumed.——Balloon telegraphy is likely to be largely used in America, should the unhappy contentions which now agitate that country acquire the features of a regular war. Mr. Allan, of Rhode Island, has been appointed aeronautical engineer to the United States Government.——M. Bonelli, of Milan, has patented a method of telegraphy by which messages can be sent and printed at sixpence each. It is, we understand, to be carried out immediately between Liverpool and Manchester.

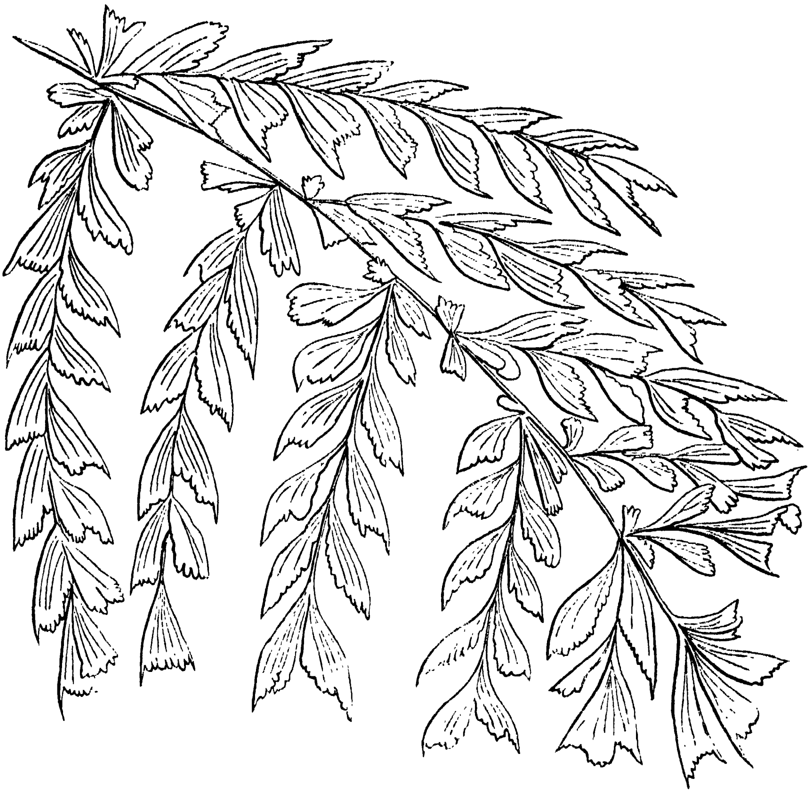


FIG. 1.—Apex of a Frond of the Wine-Palm, showing the peculiar forms of the leaflets.

THE WINE-PALM.

WE last year drew attention to a species of palm—one of the cocoa-nut family—which was flowering, for the first time in Europe, in the large tropical conservatory of the Royal Botanic Garden at Kew.* This magnificent structure gives advantages for the cultivation of these princes of the vegetable world which no other garden possesses; and another palm is now producing flowers there, which was never seen in bloom before in this country; at least, never in such perfection, for we believe a poor half-starved plant was, some years ago, forced into producing an abortive attempt to flower. Our readers must not suppose that because we bring this tree prominently before them, and speak of it with something approaching to enthusiasm, that the flowers are very showy, and of some bright and gorgeous colour; on the contrary, the inflorescence of this wine-palm is far inferior in this respect to a bed of scarlet geraniums, and probably not one person in twenty out of the thousands who daily throng

* See RECREATIVE SCIENCE, vol. i. p. 69.

this garden ever see the flowers of this palm, half-hidden as they are in a mass of tropical foliage of the same colour as themselves. No; we speak of it for two reasons: first, on account of its rarity, and to record what must be looked upon as a triumph of horticultural skill; and, secondly, because of the interest attached to the tree in its native country.

This magnificent specimen of what is called the Wine, or Toddy Palm (*Caryota urens*), is planted in the middle of the large palm-house, and the leaves have more than once pushed their way through the glass at the very apex of the roof. It has a clear, smooth stem, slightly marked at intervals with horizontal lines—these are the scars left by the fallen leaves—it is as straight as a mast, and bare of foliage to the height of about thirty-five feet. The upper part of the stem bears a noble crown of leaves, the points of the young leaves being nearly seventy feet from the ground. The leaves, or fronds, are about eighteen feet in length, and the tree has fourteen of them. They are twice divided (bi-pinnate), and the ultimate divisions are of a wedge-shaped form with jagged edges; the sketch (Fig. 1) will give some idea of their peculiar shape.

The inflorescence of this tree, like that of all other palms, is at first inclosed in, and protected by a huge sheath, called a spathe. These spathes are produced from the axils of the upper leaves; when fully developed they are some four or five feet in length, and have the appearance of a great club. They eventually burst open on the lower side, and a pendant mass of long flexible shoots (technically called the spadix) make their appearance. These are of a light green colour, as well as the minute flowers with which they are thickly studded. The flowers are unisexual, that is those that afterwards bear the fruit, do not produce any stamens; and, by one of those beautiful arrangements with which the attentive observer of Nature is constantly meeting, we find that the staminiferous flowers are developed towards the extremity of the shoots, while the pistiliferous blossoms are found only near the base, where they are certain of a sufficient supply of nourishment, and where, if the shoots be lashed about by the wind, the young fruits are less liable to injury.

One great peculiarity about this palm is, that it begins to produce its masses of flowers towards the apex of the tree, and each succeeding flower-shoot grows in the axil of a leaf a little lower down the stem. The effort to produce such an immense quantity of flowers seems to exhaust the tree, and as they are formed lower and still lower down, the tree dies downwards too. The mission of the tree is fulfilled, and it eventually dies of pure exhaustion. We may therefore look upon this noble specimen as being doomed to destruction, but it will no doubt take several years before the energy of such a tree is conquered. Fortunately there are several young plants ready to take its place when it eventually succumbs to its inevitable fate. Fig. 2 gives a sketch of a very young Caryota, probably not more than a year old; it is always interesting to watch the series of transformations in form which a young seedling plant goes through before reaching its normal adult state.

This wine-palm is a native of the East Indies, and from its many useful qualities it is often seen there in the neighbourhood of villages, as well as forming whole forests near the base of mountain ranges. With regard to its uses we cannot do better than quote the words of Roxburgh, who is one of the best authorities on East Indian plants. He says—"This tree is highly valuable to the natives of the countries where it grows in plenty; it yields them, during the hot season, an immense quantity of toddy or palm-wine. I have been informed that the best trees will supply at the rate of nearly a hundred pints in the four-and-twenty hours. The pith, or farinaceous part of the trunk of old trees is said to be equal to the best sago; the natives

FIG. 2.—A young Seedling Wine-Palm, probably about a year old.

make it into bread, and boil it into thick gruel; I have reason to believe this substance to be highly nutritious; I have eaten the gruel, and think it fully as palatable as that obtained from the Malay countries." The only information I can give as to the way in which the toddy is procured—for plants are too rare and valuable for us to try the experiment in this country, and no traveller seems to have described the process—is what Loudon tells us. He says—"When the tree has come to maturity, there comes out a bud from the top; this bud the natives cut off, and prepare by putting salt, pepper, lemons, garlick, leaves, etc., over it. They daily cut off a thin slice from the end, and the liquor drops into a vessel which they set to catch it."

We have not yet finished the list of the uses to which the products of this tree are applied in its native land. Dr. Seemann, in his "Popular History of Palms"—a work full of information, conveyed in a most entertaining way, and which will be found deeply interesting to every young student of Nature—furnishes us with the following facts. A large quantity of jaggery, or palm-sugar, is made from the sap of this Caryota. There is an entire caste in Ceylon called Jaggeraros, from being employed in its preparation. Sugar-candy is obtained by boiling down the toddy till it becomes of the consistency of syrup, which is then left to evaporate in the sunshine. The "Kittul fibre" of commerce is furnished by the foliage of this palm; it is made into fishing-lines and bow-strings, and ropes made from it are sufficiently strong

to be used in confining newly-captured elephants.

Loudon informs us that this palm was first introduced into English gardens about seventy-five years ago. The name Caryota was given by the Greeks to a variety of date-palm, from which they obtained an intoxicating drink. The specific name, *urens*, refers to the acrid quality of the outer covering of the fruit, which consequently is not edible. There is another species of Caryota much more frequently seen in the hothouses of this country, and which is often confounded with the one we have been speaking of—this is *C. sobolifera*, a much dwarfer palm, seldom making much stem, but throwing out numerous shoots from just above the surface of the soil. This species flowers very frequently.

C. W. CROCKER.

Royal Botanic Gardens, Kew.

A LONDON NATURALIST'S HOLIDAY.

"Accidental participation in natural history excursions has converted many an idler into a man of science."

EDWARD FORBES.

EVERY one who has read the "Glaucus" of the Rev. Mr. Kingsley, or the writings of Messrs. Gosse and Lewes (and who has not?), well know that in order to obtain a more intimate acquaintance with the forms of animal life therein described, than can possibly be furnished by their own aquaria, however well stocked, it is necessary to resort to Ilfracombe, or Tenby, or Torquay, or Jersey, as the case may be, where in each or all one is sure to find a supply of objects of the highest interest. It is the aim of the present paper to endeavour to show those naturalists who reside in London, and have not the time or opportunity to spare for these extended journeys, how much may be done near home by a very small expenditure of time and money, after the scheme to be faithfully recorded in the following pages. We will ask the reader to accompany us, one day in September last, by the 7.50 a.m. train from Fenchurch Street to Southend, and although we decline to state whether we took a return ticket by the humble though cushionless second-class carriage, at the very low rate of two shillings, or recklessly tendered our three shillings and sixpence for the more aristocratic first-class; in either case the sum exacted cannot be deemed otherwise than moderate in the extreme for a transit of eighty-three miles.

On reaching our destination soon after ten o'clock, and having successfully fought our way through the "swarm of flies," whose drivers appear to consider it a duty to hold every pedestrian in the light of a personal enemy, we are met by a kind friend and zealous naturalist, who has prepared an ample store of collecting bottles, hand and tow nets, dipping tubes, etc., while, with provident forethought, he has already engaged for our service the handsome cutter "Rachel," of some six tons burthen, with its intelligent crew of two experienced Southenders. The tide is nearly at lowest ebb, therefore rendering the near approach of the boat to the land impossible; so walking along the dreary wooden pier, more than a mile in length, we gain the beach by a flight of steps, some six hundred yards from the extreme end. Here we begin to have the first intimation of the marine riches of the place; the pools left by the retiring tide are fringed with *Laomedea*, *Sertularia*, *Antennu-*

laria, Eudendrium, and many other zoophytes (the *Corallines* of old Ellis), whose polypidoms bear an abundant crop of parasitical *Diatomaceæ* principally *Grammatophora*, and *Licmophora*, readily distinguishable by the brown hue they impart to the zoophyte growths. While hunting in this locality for the somewhat rarer *Cellularia ciliata*, and *C. avicularia* (to be found only at the furthest range of low-water mark), let us be careful not to stray too far from the pier, or we shall soon be called to account by the ever-watchful water bailiff, who will tell us that we are trespassing, and perchance destroying by our footsteps his cherished oyster spawn.

After a single glance at the innumerable crabs, shrimps, sand-stars, cross-fishes, gobies, blennies, actiniæ, echini, etc., etc., which give life and animation to the pools, we only pause to pocket a few periwinkles, to act as scavengers in the aquaria at home, fill a small bottle or two with zoophyte tufts for after examination, and one especial bottle—half-filled with proof spirit—with the same, with a view of mounting as microscopic objects the polyps arrested in their career by the action of the spirit, before they have time to withdraw into the recesses of their cells. At the extremity of the pier we gain the boat, and are soon bowling along with a steady south-west breeze, at a rate of five or six knots an hour, in a direction midway between the Shoeburyness sandbank and the Nore Light. Apart from the interest excited by our favourite pursuit, the situation is not devoid of charms; a warm day in autumn, not too much sun, a light breeze, a good boat under us, Southend rapidly sinking in the distance, an occasional puff of white smoke, and the subsequent report telling of long-range practice by Whitworth or Armstrong at Shoeburyness, tug steamers conveying heavily freighted Australian or American liners to their respective docks, the Nore Light-ship on the starboard bow, Sheerness and the coast of Sheppy on the right bank of the river, and one of Her Majesty's gunboats (name unknown) fussing about and burning Her Majesty's coals at a great rate. Leaving the boatmen to rig out the trawl, one of the party is ranging the bottles and other receptacles ready for use; another is filling the pails and basins with clean water; a third would willingly affix the muslin tow-net to the line, but unfortunately the line has been left on shore by accident; no matter, one of the colour halliards is pressed into the service, and does duty admirably; the tow-net is then thrown astern to collect medusæ and other floating treasures. While the rest are thus busily engaged, one of our number was silently but attentively fishing over the gunwale of the boat with a small hand-net. He broke the silence with "Quick, the handbasin!" and a lovely *Cydippe* (*C. pomiformis*) was secured as first-fruits of the day's success. *Alcinoe, Beroe, Cyanæa,* and other small *Medusæ*, were quickly caught and committed to the safe keeping of the same basin, whose white material served to reflect the shadows thrown down, when the sun's rays were intercepted by the exquisitely transparent and frequently otherwise invisible *Ciliograde acalephs.*

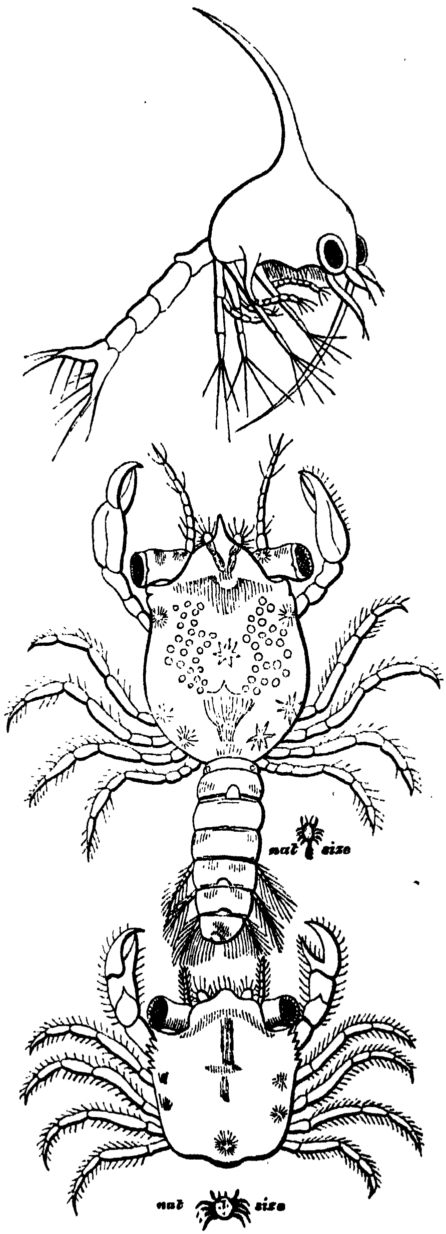
Medusæ, be they large or small, are easily detected as they float past, and as readily secured; but to capture a *Beroe*, when the boat is moving rapidly through the water, requires a combination of experienced eyesight and tact. The substance of which the body is composed is so attenuated and diaphanous, that the only indication of its presence is a faint brownish-coloured spot surrounded by a halo of flickering light caused by the action of the locomotive cilia, while the delicacy of the beautiful little creature is so extreme, that unless care be exercised it is apt to be destroyed by the pressure of the current against the bottom of the net. For the last quarter of an hour the trawl has been thrown overboard, and now all

hands are anxiously waiting the first haul, and are speculating on the probabilities of success or failure. Herein much necessarily depends on chance, since if the net has been dragging a shifting sand, the result will be "nil;" whereas if the river-bed be stones and shells, our prospects are bright and promising. As preliminary steps an old sail is spread out on the deck to receive the gathering, and the boat's way checked by shifting the jibsail. As the trawl rises slowly to the side, it is sufficiently evident that there is no lack of quantity of marine life, whatever the quality may prove to be, since when the contents of the net are emptied out on the sail, they present the appearance of a large mass of plunging, struggling, crawling existence, interspersed with shells, stones, and sea-weed. Even to enumerate the various forms of animal life now spread before us, would occupy more space than we can spare. Besides oysters and shrimps, a few small soles and plaice (one of the latter, however, weighing between two and three pounds, and therefore put on one side till supper-time), we find in the greatest profusion crabs of many kinds, the Hermit-crab (*Cancerpagurus*) predominating, the common edible crab (*Carcinus mœnas*), the more interesting velvet swimming-crab (*Portunus puber*), and two or three dwarf swimming-crabs (*P. pusillus*) with their delicately-fringed paddles; very many of the sea-spiders (as the family of the *Pycnogonidæ* are often called), *Phoxichilus spinosus*, and *Pallene brevirostris*, common sand-stars (*Ophiura texturata*), and the cross-fish (*Uraster rubens*), the especial object of hatred to the fishermen from its destructive propensities to the young oysters, and hence christened by Professor Forbes, "a sub-marine Dando," in numbers; but brittle stars (*Ophiocoma rosula*) only few and far between. Attached to the boulder stones *Actiniæ* in plenty, but chiefly confined to *A. crassicornis*, several specimens of cuttle-fish (*Sepia officinalis*), and squids (*Loligo vulgaris*), large *Medusæ*, *Doris tuberculata*, *Eolis coronata*, *Flustræ* innumerable, and one splendid sea-mouse (*Aphrodita aculeata*), nearly four inches in length. The above list, although very imperfect, may serve to convey some idea of the success attending our first haul; but to these must be added a large store of interesting objects requiring the test-tube and Coddington hand-lens for their detection, and only to be fully known and appreciated by the aid of the microscope on our return home. Having secured our captives, the first care was to make selection of such as should prove most portable and most likely to survive the journey to town. With this view the fishes and oysters were collected by the boatmen to be thrown back into the water to grow bigger, or to be eaten hereafter as their size might warrant; the crabs, spiders, cross and star fishes, medusæ and large anemones were returned to their native element, a few only of the very smallest of each being reserved for the tanks at home. While depositing these in their appropriate bottles, a small squid some inch and a half in length was included; naturally indignant at the confinement, he ejected a large quantity of his pigment, sufficient to blacken the whole water, but by emptying the vessel and refilling several times with clear water, he became again visible, and exhibited his side fins in beautiful action.

But let us leave the picking and sorting for a few minutes, and see what the muslin tow-net has done for us. Lifting this carefully from the water, we find the net discoloured by a brown scum of a peculiar glutinous character, indicating the presence of *Diatomaceæ;* accordingly, on a close inspection by help of a Coddington of short focus, we detect *Rhizosolenia styliformis* in abundance, and another species, which a later examination with the microscope proved to be curved at the extremities like a bird's claw, perhaps the *R. calcaravis* of Schultze,

Amphiprora alata, and, to our greater satisfaction, a large supply of one of the most remarkable genera of the group, *Bacillara paradoxa*. It would be difficult indeed for the naturalist, who sees for the first time the rapid and eccentric movements of this wonderful diatom, seemingly directed and controlled by a sense almost akin to volition, to accept without hesitation the proposition that it belongs to the vegetable and not to the animal kingdom. The alternate and apparently rhythmical elongation and closing up of the staves of which it is composed (whence the name of *Vibrio paxillifer*, given by its first discoverer, Otto Friedrich Mueller) must be witnessed to be understood, since all drawings—not excepting the faithful delineations given by Ehrenberg in his great work "Die Infusionsthierchen als vollkommene Organismen"—utterly fail to convey a true impression of this remarkable phenomenon. Mueller thus quaintly describes what he terms this "Animalculum, vel congeries animalculorum mirabilis:"—"Demum nocte 6 and 7 Octobrem, 1781, aspectu fili flavescentis, sese in longum producentis et in breve contrahentis, ac ex his paxillis compositi, obstupefactus, novo-que phaenomeno gavisus, ejusdem variis evolutionibus incubui Paxilli oculo nudo inconspicui cute pellucida membranaque intestinali flavescente, punctisque binis aut tribus sparsis constare videntur." The bottom of the net was covered with a layer of the smaller *Medusæ*, *Beroes*, and *Cydippes*, while every here and there the muslin was spotted with minute gelatinous specks, each marked by a distinct black dot or dots, which, when the net was inverted in a basin of clear water, we found to be the young of the crab, the *Zoea pelagica* of the earlier naturalists, first restored to its proper place in the kingdom of animate nature by Thompson, in 1835 ("Phil. Trans.," vol. cxxv. p. 359).

The annexed sketches (copied with permission from Professor Rymer Jones's "Ge-



Transformations of the Crab.

neral Outline of the Organization of the Animal Kingdom," and verified by comparison with numerous examples obtained by this day's fishing) will afford to those of our readers who take interest in developmental anatomy an accurate idea of the successive changes undergone by the crab from the freely swimming infant, its dorsal surface prolonged upwards as a horn, a similar, though smaller, horn projecting downwards from the head, a tail longer than the body, unprovided with false feet, and the last two pairs of feet ciliated for swimming. In its next or megalopoid stage (so named from the disproportionate size of the eyes), analogous to that of pupa in the class *Insecta*, the horns have disappeared, the eyes become pedunculated, and the tail flattened and furnished with false feet, called sub-abdominal fins by Thompson; while in the third stage the tail is permanently folded and fixed under the thorax, and the adult condition foreshadowed.

But now the shifting tide and failing wind warn us that it is time to think of returning; so, after an interval of ten minutes devoted to luncheon, with appetites sharpened by the fresh air, the boat's head is laid for Sheerness, on the first tack homewards. The four next hours were well spent in a repetition of the same manœuvres already described, occasional casting and examination of the trawl, but preference given to the employment of the oyster-dredge, as being the more manageable of the two, and frequent visits to the tow-net, until, owing to the continued slackening of the wind, this last had to be laid aside, from being found to deaden the boat's way too much.

The flood-tide brought us several new objects; amongst these a large crop of *Noctiluca miliaris*, a chief cause of the phosphorescent scintillations so frequently witnessed in the sea off the southern coast of Britain, and in all warm latitudes.

A jar of water, containing a full supply of these minute *Protozoa*, was conveyed home in safety, in the hope of being able to recognize the process of "self-division" described by Mr. Brightwell in the "Microscopical Journal" for 1857, as first seen during the autumn of the preceding year by Lieutenant-Colonel Baddeley, but the result of very many careful observations was not fortunate to this end; possibly the time of year was unfavourable, since the self-multiplication of *Actinophrys* (a genus in near affinity with *Noctiluca*) proceeds with greatest energy during the spring season.

In successive skimmings of the surface of the water we found, in addition to the Diatoms mentioned, *Biddulphia Baileyii* in quantities, many of the frustules of the largest size, and sometimes, though but rarely, filled with endochrome. *Eucampia* was not unfrequent, often disposed in whorls of six or even eight turns, overlapping each other as we find in *Meridion circulare;* besides *E. zodiacus*, another species was met with, in which the height of each segment exceeded the breadth threefold. The constant occurrence of these and many others of the commoner species of the Diatomaceæ, floating freely on the top of the stream, opens up the interesting question of their first production, whether in all cases from the Algæ composing the submarine Flora at the bottom, and thence dissevered by the action of the winds and waves, or whether the act of reproduction goes on in their detached condition. Professor W. Smith is silent on this head, but the balance of probability is in favour of the first supposition.

But it is time to bring the "Voyage of the Rachel" to a close; our desire has been less to afford a complete catalogue of the numerous objects examined, than to show how large a field of observation lies within easy reach of the Londoner. To those not acquainted with the locality, the mention of the banks of the river might induce the belief that the Fauna and Flora are those of

a fluviatile district, but such is not the case, they are essentially marine, and at one period of our visit, when the tide was at the lowest, a sample of the water was preserved for the purpose of comparison with a similar portion brought from mid-channel or the German Ocean, but Casella's salt-water test-glass indicated no appreciable difference in the density of each.

Before gaining the shore, we boarded one of the shrimping-boats from the neighbouring village of Leigh (whose inhabitants obtain a livelihood by supplying the markets of London and Gravesend with this favourite esculent amongst the lower classes, maintaining for the purpose a fleet of more than two hundred boats), and witnessed the operation of separating the shrimps from the crabs, star-fishes, shells, etc., brought up by the trawl, and their immediate consignment to a large cauldron of water kept boiling on the deck. The sight of the large amount of refuse shells and the like, so entirely valueless to the fishermen, but so rich in objects of interest to the naturalist, suggests to the economist a ready means of pursuing his studies by entering himself as a passenger on board one of these boats for an hour or two, while the minimum of expense incurred may be estimated by stating that, on the occasion of a similar visit to an oyster-dredger at the mouth of the river Orwell, we found that the present of a shilling and two or three cigars was held by the fishermen to be ample recompense.

In completing the record of the results of the day's excursion, it may suffice to say that the Squid only lived for a few hours, the Aphrodite but little longer, the Beroes and Cydippes, having been transferred to a tank in the aquarian-house of the gardens of the Zoological Society, flourished for a week or ten days. Some dozen specimens of *A. crassicornis* (six or eight of which attached to a fragment of the thigh-bone of a large ruminant) remained all the winter in another tank in the same gardens, and were only removed to make way for new occupants, while very many of the "smaller deer" still hold a place in our own collection, and serve to remind us of a pleasant, and happily not ill-spent day. J. NEWTON TOMKINS.

GEOLOGICAL RAMBLES—MONTGOMERYSHIRE.

As the season has now arrived when we may hopefully recommence our geological rambles, I believe I shall be doing good and acceptable service to the readers of this periodical if I retrace my devious steps for their benefit, and shall also be precisely in accordance with the purpose of RECREATIVE SCIENCE. I have become acquainted of late years with the wants and wishes of many young and middle-aged students of natural science, with reference to brief and easily-manageable excursions from our great cities and towns, and especially for the study of geology in the field, the hill, the quarry, and the mine. There are hundreds of such students who can only obtain a week or two weeks' holiday at one time, and who find it essential to economize both time and money. I propose, therefore, in the present and some succeeding papers, to sketch such geological excursions, narrate such incidents, point out such localities of geological interest, and describe such fossils, as may be interesting to those who only read and do not travel, but especially serviceable to those who intend to follow my footsteps. By thus acting as their forerunner, I may save them much local inquiry, many mistakes, and much loss of

time and temper. They may profit by my experience and gain by my losses, and may, in a few lines, obtain the condensed information which perhaps has cost me days, and miles, and coin, but feebly represented by six or a dozen lines of print.

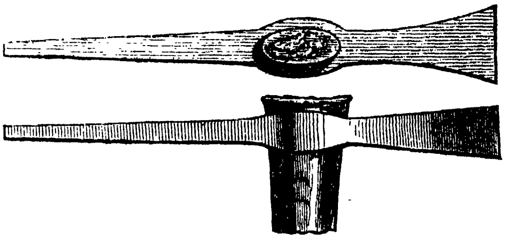
It is a great point to set out well, to start with what you want, and with nothing that you do not want. I may commence with a few hints on equipment, which, though apparently trivial, will be found important enough in the issue. First, then, I will suppose my readers are only able to journey singly; if two or three of like minds and like means can form a party, it will be far the better plan for enjoyment. But they must be well-assorted persons; by no means let your companion or companions be ungeological, and, least of all, opposed to geology and to fossil collecting. I have gone with those who have been indifferent to the study, and nothing can be more trying. I once took an old friend with me for a few days, who declared he should like to learn, but who turned restive the second day, declined to carry the bag a furlong, and got so knocked up by accompanying me in all sorts of difficult places, that he has looked askance upon me ever since. Another time I took a French gentleman with me, from Oxford to Stonyfield—a long, weary walk, it is true; and, having purchased many fossils, I asked his help in carrying them in turn and return. I shall not soon forget his broken English and almost broken back, as he groaned under a mile or two of the stone-bearing bag—"Oh, dis bag; he is ver' heavy, ver' heavy; I tink I will not have him, my dear friend, any more. Oh, oh, I am ill, ver' sick, with this bag of yours; I will throw him away." I declined to take the bag at that minute, when down he dashed the bag on the road, looking at it with concentrated disgust and hatred.

If you can secure one agreeable geological companion, a good walker, a good talker, and a man with a soul in his eye and an eye in his soul to look with hearty appreciation upon natural beauties, and to find not only "sermons in stones," but also songs in stones and history in hills, and queries in quarries, and food for the mind where food for the body is indifferent, or indigestible as a petrifaction; then take that man, and be thankful for him. He may be useful to you, as well as agreeable. Geological rambles do not always turn out perfect enjoyment. Not only are there disappointments and mistakes, but sometimes also mishaps which a lonely wanderer can hardly deal with. Last month a friend told me of one which befell him, and is very likely to befall others. He had visited a coal-pit, found a few ferns on the shale at the pit's mouth, and was carrying them away, having a large piece of coal shale under one arm, when out ran the owner of the pit from a shed, and, hastening up to him, collared him menacingly, and exclaimed, "Ah, you rascal! I've caught you this time. A pretty lot of my coals you have stolen, one time and another; and now I'll have you up and put in jail, as sure as you've a head on your shoulders." It was only with great difficulty and much earnest remonstrance that my friend got free at last, himself much excited and annoyed. A companion in this dilemma would have been very acceptable. It may be as well, too, that I should notice that fossil collectors do not always behave well, and often leave bad reputations behind them. I heard recently of one who came from Shrewsbury, went to Treflach Quarries, of which I shall speak presently, employed a workman there three hours in breaking out fossils, and then gave him sixpence! Of course, such meanness tells badly for the next comer. Moreover, apart from meanness and paltry conduct (which, by the by, is sure to find fame to the discredit of the party concerned), there are collectors who, though not mean, are mischievous. There are places where the walls, being built of loose stones from shallow pits, are the best

repositories of fossils, and certain mischievous, or rather, inconsiderate, ramblers pull down the top stones, and break them up for fossils. It is as well to note that there is a farmer at Cefu Coch, near Llangollen (in the Bala limestone district), North Wales, who is vengefully awaiting the next mural marauder who goes that way hammer in hand. The farmer has been heard to declare that "hanging is too good for 'un," and he only wishes he may "catch another of they hammering rascals; he don't care who he be, he'll sarve him out so as he won't never hammer no more at his wall." I mention this by way of warning, because I shall speak of the fossils to be found there, and ought to hint the reception that will be found there also for the next trespasser. There ought to be two stout friends with the geologist who makes the attempt, and those friends provided with two stout sticks.

A word or two as to the personal equipment of the rambler may be useful. I should take, as I have lately done, a capacious angler's basket to hold the smaller fossils and rock specimens. As it is made to fit to the back, it is more easily carried than a knapsack, and I have found that when slung across the back with a good strap, it is more manageable than anything else I can employ. Another good thing is a tough, but pliable, leather wallet of large size, with an inside division, or pocket or two. Either or both of these are better than carpet bags, which severely try the arms when heavily loaded and carried ten or more miles. It would be no slight service if the Geological Society would offer a prize for the best fossil-bearing bag or basket. Something particularly convenient might be devised by some ingenious and practical collector.

Of hammers, several figures have been given by different geologists. The one which I should recommend as most generally convenient is of the subjoined shape. The pointed end will work as a pick, and penetrate into shale and clay, while the hammer end will deliver a heavy, shattering blow. Any good tool-maker would fashion such an one, and lighten it by slightly curving inwards some portions of the length. It is important that it should be of the best metal and well case-hardened. If of two or three pounds weight it will be all the more useful. I think Knight and Co., of Foster Lane, Cheapside, keep geological hammers always in stock, but I should prefer having



one made under my own directions. I intend to have a long handle inserted in my own hammer, so as to use it as a walking-stick, by which means the weight is taken off from the arm when continually swinging the implement from the end of the handle in walking. I fancy this simple arrangement would render a heavy hammer portable with a stout glove, without fatigue. Add to this a couple of well-tempered masons' chisels; order your tailor to make you a loose coat of tough material, with as many pockets as he can devise, and in one or two of these carry writing-paper, string, and pencil for labels on the spot. In another pocket have a small magnifying lens and a strong pocket-knife. In another let there be a good map of the country travelled over, strongly mounted on canvas, and folded. You can take the maps of the Geological Survey, if you please; they are undeniably the best, and their only disadvantage is, that the large scale renders it necessary to take a large quantity of mapping. If you traverse only a limited district,

by all means take the Geological Survey's maps and sections, coloured geologically. They are sold by Stanford, mapseller, at Charing Cross, and are divided into sectional portions, which may be separately obtained. I always have on my table the plain maps of the Survey for the part I propose to visit, as these are very low priced, and can be coloured by one's self at leisure. To colour one portion from personal observation of the district is a profitable exercise, and, if erroneously performed, the loss is only that of a trifle. Of North Wales, on the whole, the most convenient map I know is that of J. and A. Walker, London and Liverpool, March, 1824. The routes are distinct, the names all very legible, and the parts I have travelled over accurately laid down. An engineer lately examined my copy, and pronounced the map to be an excellent one with reference to remote districts known to him. It has also the distance marked in miles along the leading roads. I should not hesitate to use it for any part of North Wales. There is an older and much larger map of North Wales, in nine sheets, by John Evans, Esq., of Llwyn-y-Groes, which I have consulted, but the scale is too extended for convenience of travel, however useful it may be in the library.

I hope to secure the favour and attention of my readers to some geological rambles over the most interesting districts of North and South Wales, and, for the convenience of those who may desire to follow me, I shall break up the whole into short and manageable excursions, such as the busiest and the least-favoured of fortune's sons may accomplish. I am anxious that young and even older men, who have hitherto thought geological excursions out of their reach, shall find that five or six days and as many pounds may be pleasurably and profitably spent in this way. For their sake, I shall proceed in this present paper to show what may be done by an excursion train from London, and, of course, more conveniently still from Birmingham, or any of the adjacent towns, at a very small cost, provided the plan be well laid beforehand, and the places of interest be precisely known.

Taking the Great Western Railway excursion train from London, I have recently been over the ground I am about to describe, obtained (in two visits) the fossils about to be named, and met with the little incidents which I may perhaps be permitted to notice in passing.

On arriving at Oswestry, I took train to Llanymynach, on the borders of Shropshire and Montgomeryshire. On a previous visit I had walked the distance, and was now thankful for the railway, slow and unpunctual as it was. Six inns, or public-houses, await the visitor to this village, and he can take up his abode at any one, from that of Mr. Lloyd (who has built himself a private house, to which his wife prefers the old inn) to that of the Cross Keys, or the little public house, known as the Dolphin. This is a beautiful station for a day or two, and a quiet resting-place for a night or two also, unless the visitor have the ill-luck which attended me this last time, viz., of having his quiet quarters suddenly over-run by a dozen working men from Manchester, who also make use of excursion trains, and give loose to tongues and feet at the same time. I had admired the extensive prospect from Llanymynach Hill for the third time in the evening of a clear day, and returned to mine inn with peaceful thoughts and grateful heart, when lo! six or eight Manchester foremen or operatives had taken possession of the little room, and were in the height of talkative freedom. Now, no man has more delight in seeing working men relax themselves rationally than the writer, but when it comes to songs half the night, and personal roughness all the day, what may be relaxation to the one party is sad annoyance to the other. In the next room to mine, and but thinly

divided from it, were three honest operatives, one of whom had a hacking cough, the other a thunderous snore, and the third a musical voice, that is, as he thought. The poor fellow with the cough I pitied; the sleepy fellow with the sonorous snore I envied, since I slept not a wink; but the happy fellow with the musical voice, though my near nocturnal neighbour, I could not love as myself. While he sang into the small hours I only wished him under a bale of Manchester cotton, instead of upon a bolster, and I longed for nothing more than a handful of the same cotton to stuff into his mouth or into my ears. I regret to say that many of these Manchester and Liverpool excursionists do not leave a pleasing reputation behind them. My landlord at Meiford showed me a letter from one of your Liverpool excursionists, in which he entered into the minutest orderings of beds for four, "cotton sheets preferred," etc., etc., and, sad to say, only two of the four came, stayed only half the promised time, and left the landlord so displeased that he almost declined to receive me, for what reason I could not conjecture, until I replied in the negative to his inquiry whether I came from Liverpool or Manchester. Would that these particular gentlemen were a little less particular about cotton sheets, and more so about courteous demeanour. I fancy geology would benefit them, for I am sure that in most cases "emollit mores, nec sinitesse feros."

I may observe of Llanymynach Hill that it commands a very extensive prospect over the adjacent country, embracing the far-seen Breidden Hills and the rivers Fyrnwy and Tanat, winding far along and around in various glistening reaches and in sweeping horseshoe curves, both beautiful and liberal tributaries of the Severn, which may be espied remotely rolling on.

On the east, you have an extensive view over the plains towards Shrewsbury, and on the other side the rugged county of Montgomery. In front are the Ferwyn Mountains in the distant horizon. Immediately beneath you, on the west side of the hill, runs the rampart made by Offa, King of Mercia, to divide his country from Wales. It is called, in Welsh, *Clawdd Offa;* in English, Offa's Dyke. Though now difficult to trace, it commenced at the River Wye, towards Bristol, and passed along the counties of Hereford, Radnor, part of Salop, and Denbigh, and ended at Trenddyn, in Flintshire. It was simply a mud wall, yet it formed the line of separation between the two countries till about the period of the conquest. I believe I traced it running up this hill, near two or three cottages. Parallel with two other dykes, across this hill, runs a rampart of loose stones, with a deep foss, which follows the brow of the hill, and encompasses it for about one-half of its extent. This was probably raised by the Romans, who wrought a mine or two here, to protect their ores from plunder by the Britons. Some copper is still mined here. The huge masses of mountain-limestone here display their true external characters, and justify the distinctive of "mountain." They are largely quarried for lime, but appear to be nearly destitute of the usual fossils.

The prospect alone from this hill, if enjoyed under the beams of a morning and evening sun, when the rivers flash and glow, and the hills unfold their shifting hues, and the wild birds carol overhead; this prospect alone, I say, would repay the journey from London, and it may be obtained with ease and quietude, provided always the cottonopolists are away or at home.

From Llanymynach to Welshpool the train conveyed me and a Cornish miner, who had addressed me by reason of the free-masonry of the hammer. He at once guessed me to be "a mineral man," and begged permission to accompany me for the day. I inquired if he was a good walker, which he affirmed he was, whereupon I acceded to his

request. Knowing Cornwall well myself, we soon got upon mines, and lodes, and cross-courses, and "elvau," and "canisters," and the other technicalities of Cornish mining. He took wonderfully to me during such talk, but I evidently fell in his esteem when I began, at Welshpool, to hunt for fossils. "Why," exclaimed he, "there's not a bit of metal in any one of them; you couldn't get an ounce of copper out of a ton of them." Of this remark I acknowledged the truth, yet still persevered in hammering. It was manifest that he now thought me a fool, for he soon took his leave with an ill-concealed contempt.

I was looking all around for the "Trilobite Dingle," mentioned by Murchison as being at Welshpool. Nowhere could I find the slightest indication of it. The chief quarry, the Standard Quarry, was evidently of trap, a lightish green trap, and similar to that of the Breidden Hills. I was about to quit the town in disgust, when I met a clergyman walking down the main street. In intellectual difficulties of a topographical order, I always take "the benefit of clergy," since they are generally able to help a naturalist in distress, and sympathetic with him in his hobbies. As to the lower laity in rural places, you had better keep your object and your hammer concealed. To make them understand your views and aid them is utterly hopeless. That a man should come one or two hundred miles to pick up stones, they never will believe, and that he conceals some ulterior and questionable object under such a pretence is their invariable opinion. They would rather believe him a rogue than a fool, and a methodical knave than a madman. If in any extremity you are obliged to bear the imputation of one character or the other, I recommend that of the fool or the madman; the latter is the preferable one, since it secures you elbow-room and solitude. No rustic cares to trouble himself about a madman with a heavy hammer in his hand, and the more you haunt solitary places, and pick out fossils, and wrap them up in paper, the more closely the character fits you, and the more perfect your immunity. The only nuisance that can attend you is, that the landlord or waiter at your inn will perhaps secretly empty your pockets and bag of the fossils, and throw them away, to prevent you doing harm to yourself or others. Therefore, a lock to your bag is of advantage.

The courteous clergyman whom I addressed at once comprehended me, and proffered to accompany me to the only spot likely to answer to my inquiry. Without him I could not have found it, for it is no quarry, but simply a little dell in a coppice, through which a rill trickles and wears down the red shale standing edgeways on each side of it. This shale is presumed to represent the Caradoc beds (commonly sandstone). It is remarkable that it should be very near a great mass of trap, or light green stone, which has intruded upwards from the insides of the Lower Silurian beds; and still more remarkable that this shale should be the sepulchre of innumerable trilobites, which lie thick and threefold in it. Then a vast basaltic or trappean dyke, with its fiery deadness, stands next neighbour to a mass of mud, which must once have teemed with crustacean life most prolifically. The trilobites are apparently all of one species, the *Trinucleus concentricus* (formerly named *T. Caractaci* by Murchison). I could not extract one perfect specimen, but I obtained twenty imperfect portions. Any one going to this spot should have a pickaxe, and a large box to carry the pieces of shale flatly, and these should afterwards be dried in an oven. Some of my specimens crumbled to pieces under exposure, while the few I dried in an oven are now by my side. The annexed sketch will represent the head of this Trinucleus sufficiently for recognition. Fig. 1 shows the head with its concentrically-dotted

fringe. Fig 2 shows this fringe separately, as it is often found upon the shale, the head

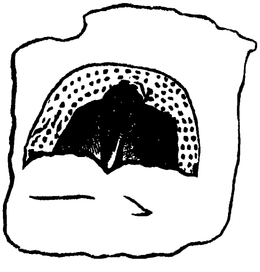


FIG. 1.

not being so frequently present. The circular dottings of this fringe have probably given rise to the name *concentricus.*

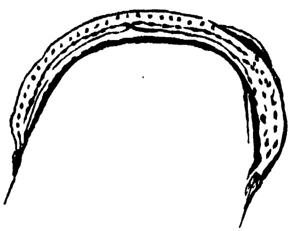


FIG. 2.

After an hour's research, I repaired, by invitation, to the Rev. Mr. P——'s lodgings, and spent a very pleasant hour in conversation with him. He showed me trilobites from Middleton, near Chirbury, which place is to be reached from Shrewsbury, and I fancy would repay a visit.

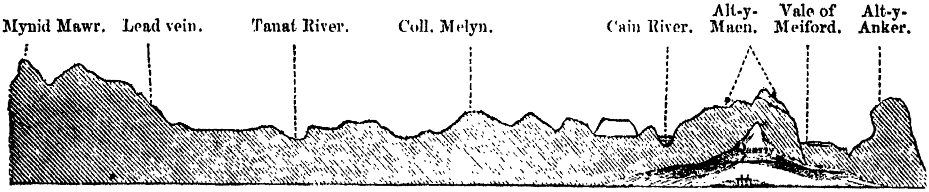
A visit to the exterior of Powis Castle, and a walk through its fine park, especially the upper ridges, would of itself reward the visitor to Welshpool. There are not many more picturesque views than the one which enchants the climber up the hill in front of the castle, when he turns away from the castle-gates and looks back on the noble Breidden Mountains. The principal entrance to the castle is a gateway between two massive round towers, the ascent to which is by a very long flight of steps, over two great terraces. By walking half round the castle on the footpath, you get a tolerable acquaintance with its imposing towers, flanked with semicircular bastions, and its dead red walls. The interior, I was informed, is not very remarkable, and restorations have so far replaced the ancient inside and outside, that the view of the grand front affords nearly all of the truly antique now remaining. I have transferred some fine ferns (a species of *Trichomanes*) from the castellated walls to very much humbler walls in London, and I am hopeful that they will survive their change of place and descent in life.

I returned to Llanymynach by the railway, which approaches the Breiddens, and affords an excellent view of the vast rock with Podney's Pillar on its summit, which form one extreme of these hills, and of Moel-y-Golfa, which forms the other terminal hill. You may speculate, as you rush past, on the eruptive force which elevated these vast bosses of igneous rocks from below, and, if you climb them, you may look at a mine of sulphate of barytes, which is there worked to a profit, and will yield some specimens of the mineral. I have a fine large crystal, obtained from this mine. The best view is from Moel-y-Golfa, and this might be approached by railway to within a mile or two of its base.

Next morning, away for a walk of nine or ten miles, to Meiford. I followed that fine river, the Fyrnwy (pronounced Verniew), which winds along with ample volume in wet seasons, and makes up half the interest and the beauty of the scenery. What would such districts be without such rivers? Three miles on the road is Llansantffraid, a pretty hamlet. Soon we cross a tumbling, turbid, brawling mill-stream, called the Cair River. This comes down from the hills about Llanfechan, and would, I imagine, be worth tracing upwards in summer. From this stream to Meiford, six or seven miles, I believe, I scrutinized every heap of stones by the sides of the road. I soon found I was amongst the Caradoc sandstones of Murchi-

son's Siluria, which might be expected to yield the characteristic fossils. Almost all these stones come from a quarry about three miles further on, in the noble hill of Alt-y-Maen. There we find an admirable display of this part of the silurian series of beds. The hill rises up sheer from the roadside, and, where the quarry has been opened on its side, we see its stony composition. The annexed section across the country will sufficiently display for the whole district the position and relation of the several beds.

The fossils I obtained by an hour's hard hammering in the Alt-y-Maen quarry were—*Orthis expansa*, a very characteristic shell of the Caradoc sandstone, or Bala beds, several specimens of a small common Corltris which prevails throughout this stone, and one or two imperfect specimens of a spiral univalve, like the Murchisonia of the mountain limestone. In returning, while breaking at a heap of roadside stones, I found a good pygidium (tail-half) of a rather large trilobite, probably an *Asaphus;* but I found no



Fossils.—Trilobites and Encrinites. Undulations of Caradoc Sandstone. (Fossils in Quarry.)

The strata in this range belong to the age of what Murchison has classed as the Lower Ludlow, and below them the Lower Silurian, of which one important fossiliferous rock is named the Caradoc sandstone, from its composing the hill called Caer Caradoc. This is found in the quarried side of Alt-y-Maen, where it is associated with immense shale or slaty beds, apparently standing on edge, and presenting their flat faces to the road at this place. The same shales form the upper ridges of the beautiful park around Powis Castle. The whole series is repeated in the troughs at and around Meiford, between the valleys of the Severn and the Fyrnwy, these troughs being bounded by ridges of the inferior Caradoc sandstone. The age of these strata may be then particularly defined as that of the Lower Ludlow rocks for one portion, and that of the Caradoc, or Bala beds, for another. The Upper Ludlow series is wanting throughout the greater part of this range, and the prevailing rocks exhibit the incoherent character of the Lower Ludlow and Wenlock shales.

trilobites in the quarry. Afterwards, ascending the hill named Alt-y-Anker, at Meiford, I looked over the shales for fossils, but found nothing, although I see this locality attached to the trilobites in the illustrations of Sedgwick and McCoy's work, and the name of Meiford attached to a beautiful encrinite (*Glyptocrinus*). I could not, however, find either fossils or fossil-finders at Meiford. Although I tried my landlord by various questions during an hour's chat, I could get no kind of geological information out of him; and he had never seen anything of geologists, except on one occasion, when a man crossed into his fields, and broke up a big stone, and wrapped up the pieces in newspaper, and pocketed them.

Meiford is beautifully situated in a vale on the Fyrnwy river. From an old wooden bridge the prospect is charming, and if a hermit once lived here, as it is thought the etymology of Meiford implies, he chose a peaceful and pleasing spot for his hermitage. Some think it is the *Mediolanum* of the Romans. The church stands in a cemetery

of nine acres, dedicated to St. Tyssilis, an old prince of Powys, and a supporter of the rites of British churches against the innovations of Austin, the monk. In the church I found a part of a very ancient tombstone, but not a soul could inform me about it. In the churchyard, the old and young of the village were, on the Saturday evening, decorating sundry graves with laurel and other evergreens, in preparation for the following day, Easter Sunday. Probably this custom descends from ancient days, and intimates a hope of the resurrection. It had a touching effect upon me, a metropolitan wanderer in this river-washed vale.

On the Sunday I was anxious to hear a sermon, but was told that at the church would be in Welsh, and that in the chapel also; but the latter the better sermon. To the chapel I repaired, and doubt not that the sermon was very eloquent. The preacher often looked at me, and perhaps addressed to me a word in season. Unluckily, it was lost upon me, but not, I hope, upon an elderly man who stood upon the top stair, near the pulpit, and grasped the brass candlestick with one hand, while with the other he The old man's countenance was my only sermon; there he stood on top stair, and on tip-toe, with approximating ear, a spectacle and an example to old and young, mutely exhorting us all below to take heed and listen while our ears were able to take in easily the precious sounds.

I returned to Llanymynach with a basket of characteristic fossils, and then proceeded to the mountain limestone quarries in the neighbourhood of Porthy-waen, stopping at the station at Llynchyss, and over the coal-measures and interstratified sandstones of Sweeney Hill, and finally back to Oswestry.

I believe I have some interesting geological notes to give upon the above and other adjacent districts, but these must be deferred to another opportunity. In the present paper I have sketched what may be accomplished in one excursion of six days from London, and what may be performed by any one at this season. I am disposed to think that the information I have now given will be found serviceable to all who may follow me. At all events, I myself should have been very thankful for it on a previous excursion over the same ground, where I often lost my way, my time, and I fear my temper, missing some of the precise spots which I have now indicated. The same route will be found sufficiently interesting as a mere walking expedition, and botanists may pull up a few unusual plants.

J. R. Leifchild, A.M.

VULTURES AND COTTON-TREES OF JAMAICA.

During a lengthened residence in various parts of the West Indies, I was in the habit of making collections of birds, reptiles, spiders, etc., and occasionally noting down facts and peculiarities concerning them. Without making any pretension to the name of naturalist, I hope I may without vanity transcribe or enlarge some of these for the readers of Recreative Science.

One of the very first objects that arrests the traveller's attention in Jamaica is the "John Crow vulture" (*Cathartes aura*). Everywhere

he sees this noble-looking but repulsive bird. Soaring, alone or in companies, in mid-air, careering often to such an immense height that they look like black spots against the fervid sky, or wheeling round and round in endless circles, with all but imperceptible movement of their wings, the traveller sees at once that this is no British bird. But from the sublime to the revolting is but a step. Not a hundred yards will have been walked, especially in the dirty and neglected back streets of Kingston or Spanish Town, but this same noble bird that was just now daring the sun in his upward flight, is seen hard at work picking out the eyes of a dying pig, or devouring with evident gusto the putrid remains of a half-starved dog. Familiar with man, and protected by law, this "obscene bird," perhaps the same as bothered Æneas and his companions at their feast, only hops or waddles on one side to allow the stranger to pass between the wind and his nobility, and then resumes his offensive but useful labours. He is the paid scavenger of Jamaica and Demerara; a penalty of five pounds being imposed on any one for killing this universal hunter-up of diseased and dead creatures, fish, flesh, or fowl, that may anywhere be lying about. It may be remarked in passing that this bird is not found in Hayti, nor in many of the smaller islands of the Caribbean chain.

It is astonishing with what rapidity any offal or meat is discerned by them. I have frequently placed a dead rat, or the entrails of a fowl in the middle of the yard, having previously searched the sky in vain for a "John Crow." I have looked all around, in the neighbouring pastures, and over the nearest plantations, and not even with my glass have I at times been able to discover one solitary vulture. We have not long to wait. In a few minutes a black shape dashes by, it is our ornithological scavenger; he makes a few sweeps over the house and round the yard to see that all is right, and in another minute, with one straight plunge, he seizes on the welcome prey, devours it on the spot, or, if not too large, carrries it off in his talons to be devoured at leisure.

I remember riding by an estate one day, on the roadside of which was lying an old hog in the agonies of death. He was grunting in pain, and trying vainly to get up. While wondering at the apparent inhumanity of the negro owners of this poor swine—for to speak the truth the negroes, perhaps from having had much hard usage themselves, are not the most merciful to their beasts—several "John Crows" perched themselves on the spreading branches of a large tamarind-tree. Presently one descended, and cautiously reconnoitered. Another minute and he had leaped upon the pig, with an awkward jump and a flap of his wings.* In a moment the beak was plunged into the eye of the animal as he lay side upward, and devoured as a *bon-bouche*. In a very few minutes others descended, and when I returned that way in the evening, some forty or fifty were at the pig, long since dead, tearing him to pieces as fast as beak and talons would enable them, and jerking down their throats the unsavoury meat with an unearthly gobble.

Riding, on another occasion, between Spanish Town and Old Harbour, I observed, at a distance, on the huge boughs of a gigantic cotton-tree (*Bombax ceiba*), a large number of vultures. On looking over the hedge I saw a dead steer, one of the draught cattle that drop so often from exhaustion in the sugar waggons; on him and around him were a troop of others, who were "falling to" considerably. Those in the tree were already sufficiently gorged. Close by the steer were several lank, half-starved negroes' dogs, some every now and then rushing in to snatch a

* "The vulture first mutes upon the body, that it may discover whether the animal be able to rise; the contact of the hot fæces arousing the hog if he be not too far gone."—(*Gosse.*) I have never been able to verify this from my own observation.

morsel, at the risk of an angry flap from the heavy wings, or a savage dig from the strong beak, and others more prudently remaining at a respectful distance, only howling to inform the vultures that they too were hungry and would be glad to go halves. When the vultures have done their work, the ants commence their minuter process of dissection and cleaning the bones, and in a couple of days nothing is to be seen but a whitened skeleton, bare and bleached, surrounded with fragments of hair, or small portions of the hide. In fact, but for these birds, pestilence and fever would be daily generated by putrifying corpses. It is a well-known fact that in the negro insurrection of 1833, the vultures nearly abandoned the south side of the island, and feasted for weeks on the unburied corpses of the misguided men, who in the parishes of St. James, Westmoreland, and Trelawney, on the north side, fell victims to the militia and the soldiers.

One Sunday afternoon we were quietly reading in our piazza, when a very venerable, and therefore experienced, "John Crow" alighted in our yard. There was nothing decaying or dead lying about, but he smelt something good in the kitchen, the door of which was open. Our kitchens in the tropics are "out of doors" in the yard. Without much ceremony he walked in, when I followed him, and closing the door after me, killed him with one blow on his head from a broomstick. He was a fine specimen; their ordinary expanse is about five to six feet, but this one measured nearly seven feet from the tip of one wing to another. I cut off his head, buried it, and in the course of a few days had a beautifully cleaned skull. The underground surgeons, the ants, had done all that the dissecting knife and scalpel could effect.

Mr. Gosse relates a story of the vulture that may aptly find a place here. He was in the frequent habit of bathing, "lying delightfully immersed by the half-hour together. On one occasion I had been lying motionless for a long time, just beneath the surface, when a vulture (*Cathartes aura*) that had marked me from a distance, began to descend in circles, swooping over me, nearer and nearer at every turn, until at length the shadow of his gaunt form swept close between my face and the light, and the rushing of his wide-spread wings fanned my body as he passed. It was evident that he had mistaken me for a drowned corpse; and probably it was the motion of my open eyes, as I followed his course, that told him all was not quite right, and kept him sailing round in low circles instead of alighting."

It was long a moot-point of controversy, that might, however, have been decided by observation, whether this vulture was directed to his food by the sense of sight or of smelling. Mr. Hill, the well-known ornithologist of Jamaica, after a careful induction of facts, has, however, decided that "it is the two senses, excited sometimes singly, but generally unitedly, which give the facility which it possesses of tracing its appropriate food from far distances."

The negroes have a proverb similar in meaning to our own "dog never eat dog," that "John Crow never eats John Crow." This is a mistake. This omnivorous vulture has no specialities of taste in receiving or refusal. If one proverb may be capped by another, we may say, "It is all fish that comes to his net." These vultures generally crowd together in great numbers previous to the approach of a thunder-storm, but by what instinct they do this, or why they do it at all, as their homes are as often in the clefts of the rocks as in the branches of the trees, that is to me unknown. He is without doubt one of the great benefactors of the tropics; those who wish to see him alive, though not in all his glory, for he is cribbed, cabined, and confined, may see fine specimens in the Zoological Gardens, Regent's Park.

Having alluded to the cotton-tree, as it is called, I will finish this paper by a brief men-

tion of this gigantic wonder of the tropics.* It is one of the most common trees in our West Indian forests. Everywhere it rears its majestic head, monarch of all it surveys. Its shape, its smooth bark, and the clustering masses of silk-cotton with which it is annually covered, make it easily recognizable. This is not the cotton of commerce, and, in fact, is of scarcely any use except to fill pillows and bolsters for the peasants, and to furnish the soft downy material for the nests of our many varieties of humming-birds. There is one on the road between Spanish Town and Kingston, whose huge branches, each one the size of a good tree, stretch horizontally right across the road, and form a natural shelter from the burning heat of the sun, beneath which we have often rested to drink in the precious sea-breeze, that "breeze which comes as no other breeze comes, and feels as no other breeze feels," or to have a draught of the delicious cocoa-nut water always to be had here from sundry tables or stalls kept by the poorer class of negroes. There were two at Mandeville, in the parish of Manchester, which I should judge to be from one hundred and fifty to sixty feet high, standing all alone in their naked majesty. These trees are of great age, as is evident from the full growth of the "spurs," which are amongst the most noticeable peculiarities of its vegetation. From the base of the trunk there are sent out vast spurs radiating in tolerably direct lines, running up the trunk some eight or nine feet, and often extending higher. They appear like flying buttresses built up purposely to support the tree, and no doubt they are intended to answer such a purpose, the open spaces between which, slightly thatched over on the top, are often converted into pig-styes by the people. The negroes formerly had, and in remote districts still have, a superstitious reverence for this tree. It is an ancient superstition, and on the West Coast of Africa the giant bombax is regularly worshipped as a fetish. I remember one tree before which the negroes used to stop; the men would take off their hats, the women drop a curtsey, and salute it with "Good morning, cotton-tree;" or "Hope your father and my father are well, cotton-tree." I was once building, and had occasion to clear some land to procure wood for a lime-kiln. In the midst of my small lot stood a cotton-tree; down I said it must go; most reluctantly did the people obey—they were ashamed to say they were afraid—ashamed to pretend to any superstitious feeling in connection with it, but for a long time not an axe would they lift against it. At length reluctantly they obeyed, singing in plaintive cadence one of their improvisatized songs, the refrain of which was—

"Poor cotton-tree!
Poor cotton-tree!
Me sorry, cotton-tree—
You must die, cotton-tree."

In the forks and from the boles of this noble tree spring many large parasitical plants; many of them orchideous, generally named, without distinction, wild pines. But often have I observed these *lianes,* some of great thickness, that had climbed round and round the noble stem of the ceiba, until having reached its top they throw over their graceful festoons, clad all the year round with enamelled green, until they again descend to the ground, thence again by new shoots to regain the summit. The tree thus surrounded is literally strangled, the circulation of the sap being entirely prevented, until there is seen a carcase of a tree perfectly dead, hidden by a tangled mass of living parasites. For this the negroes have a saying, which is uttered by them often with great glee—"This is the Scotchman hugging the Irishman to death."

Croydon. W. G. Barrett.

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* I have called this tree *ceiba;* Mr. Gosse calls it so, and also the *Eriodendron aufractuosum.* I am no botanist, and therefore give both names.

THE GREENSAND.

Below the chalk marl and gray chalk are certain strata of siliceous sand and calcareous sandstone, sometimes called "malm rock" and "firestone," which is termed by geologists "greensand," green being the prevailing colour. This passes downwards into a blue clay, provincially named "gault." This is succeeded by another set of sands and sandstone, with here and there beds of limestone, partly green and partly brown, which have been denominated the lower greensand rather in contradistinction to the upper, for in many places the predominating colour is of a dark and ferruginous tint, very unlike the upper greensand. These three subdivisions form the lower portion of the cretaceous formation. The green particles are derived from silicate of iron, and where the upper greensand comes into contact with the chalk marl, the latter contains a considerable portion of these green grains. Masses of chert and chalcedony also occur, and these, with the silicate of iron, give a remarkable and peculiar aspect to the greensand group, especially the upper division. Throughout the whole system the varieties of mineral structure are considerable, the upper greensand and gault being usually found associated together over a considerable area, and forming a clear division between the chalk and lower green sand. The thickness is extremely variable, and sometimes one or more of these subdivisions are entirely absent; and only here and there in England, as in the Isle of Wight and the coast of Kent, can the whole group be studied in detail, where the best consecutive sections are afforded. It will not be necessary here to say more respecting the mineral character of this lower division of the cretaceous deposits, because the variations and peculiarities will be noted when some of the more remarkable localities, and the fossil contents of the different beds are described; it will be sufficient to observe that these distinctions arise from the variations of structure which distinguish a coarse sandstone, sometimes containing large fragments of rounded quartz, from a fine close-grained rock of the same nature. Iron pyrite is disseminated in the upper and lower greensands, but not so abundantly as in the chalk; the chalcedonies and quartz crystals in some of the chert nodules are very beautiful; and where they occupy the place of the shelly matter of numerous species of Testacea, as at Blackdown in Devonshire, the beauty and structural peculiarities of many of the fossils are very striking and well defined. Sulphate of barytes, arsenical pyrites, hemætatic and titaniferous iron-ore, and ochre, are also met with in this deposit.

As a general rule the course of this formation follows the same line as that of the chalk, forming some of the deeply indented valleys, which, as we have previously shown, characterize the chalk range, especially in Wiltshire and Dorsetshire. In some cases it rises to hills of considerable height, as at Stourhead in the latter county, and at Blackdown in Devonshire, upwards of 800 feet above the level of the sea, and still higher at Leith Hill in Surrey. In places it immediately overlies the oolites, lias, and new red sandstone, which may be observed in Dorset and Devon. The greensand hills are sometimes quite in advance of the chalk escarpment, and often appear only as outliers, separated from the main mass. Like the chalk it may be traced from the coast near Lyme, through parts of Wiltshire and Berkshire, by Cambridge and Bedfordshire, to the Norfolk coast, at Hunstanton Cliff; thence it strikes northward by the wolds of Lincolnshire and Yorkshire to the coast north of Flamborough Head. It is a narrow tract compared with the chalk itself. Its position

in Devonshire is to some extent isolated and peculiar. It appears on the coast of the Isle of Purbeck, near Swanage, and at Atherfield and Shanklin in the southern part of the Isle of Wight. It surrounds the wealden of Kent and Sussex, and fine sections may be seen at Hythe and Folkestone. The most complete section of the lower greensand is to be found at Atherfield, of which more will be said hereafter. The greensand formation is comparatively thin in part of its range, especially in Yorkshire, Lincolnshire, and Cambridgeshire. It is thicker, probably, near Warminster and at Blackdown, at the former of which, and near Alton, in Hampshire, it occupies a very considerable extent of surface.

The soil of this group is often extremely fertile, especially where it partakes of a loamy character in the lower ground, but the heights are often barren and covered with heath. Like the chalk, the rural districts occupied by it are mostly employed in agricultural pursuits.

For economical purposes, the more compact beds are of some value both for roadstones and building; the Kentish rag, largely developed near Maidstone, being especially valuable in this respect. The firestone is used in many places for hearthstones and chimneypieces, and is a good material for walls. The greensand quarries at Blackdown have long been celebrated for the manufacture of whetstones, which are obtained from irregular concretions found in the loose sand, and employ a large number of persons. The preparation of these scythestones is, however, so injurious to health that few of the workmen are long-lived. This stone is highly siliceous.

At Nutfield, in Surrey, and near Woburn, in Bedfordshire, one of the members of this series affords a valuable bed of fuller's earth, extensively used in the woollen trade. The more ferruginous beds in the lower part of the soils are charged with much iron-ore, which might, perhaps, be profitably used for economical purposes. At Cambridge and Folkestone the upper greensand and gault contain a great number of small, irregular nodules, which yield so much phosphate of lime that a large extent of surface is now worked at the former place to obtain them, and which, after due preparation, are extensively used by agriculturists both in England and foreign countries. They are collected together, ground in a mill, and then treated with an acid. The history of these concretions is highly interesting, and it is not easy to say from whence the phosphate with which they are charged was derived. At one time many, or most of them, were supposed to be coprolitic, which would at once account for its presence, but it now seems to be pretty certain that none of them are so. These nodules have been found in other places in the greensand, and appear to prevail over a considerable extent of surface, and would be always worth getting, where they can be procured in sufficient abundance.

At Farringdon, in Berkshire, a small patch of lower greensand, of peculiar character, is much used for gravel, being so excellent in quality that it is sent to some distance.

The gault, like other clays, is much employed in brick-making.

The rich and fertile tracts occupied by the greensand formation present some picturesque and beautiful scenery; the plains and valleys are generally well wooded, and the hills often clothed with woods to their summits, having clear streams flowing near them. Kent has been justly termed the garden of England, and the beauties of Surrey are well known, with its many pretty rural nooks, shady lanes, and fine commanding views, as at Leith Hill, where the lower greensand crops out at a height of 993 feet above the level of the sea. From this spot a range of sand-hills may be traced to the

east by Godstone and Sevenoaks, through Kent, to the sea. Stourhead, in Dorsetshire, is another point of considerable elevation, to which the greensand rises, and commands a fine prospect over the vale of Blackmoor.

In some parts of Surrey, and at Blackdown, in Devonshire, the scenery is wild and dreary, and presents a striking contrast to the varied and fruitful country already described.

Where the gault is present plenty of water may be obtained by sinking through the greensand above, but it is often a strong chalybeate. The dip of the entire group generally agrees with that of the chalk. The thickness may be estimated at from seven hundred to one thousand feet.

Looking at the mineral character of the lower members of the cretaceous system, the difference in the lithological structure, compared with that of the overlying chalk, must strike even a casual observer; the general feature being green and ferruginous sands and sandstone, more or less indurated with occasional bands of impure limestone, divided by a well-marked stratum of clay. The pebbles of quartz, slate, and jasper prove its mechanical origin, and point to an ancient land of primitive rocks whence they were derived, and its gradual submergence afterwards may fairly be inferred. This may also account for the changes which took place in the ocean life of the period, and other palæontological facts of interest to be noted.

The organic remains of the period under review are, like the chalk, with one or two exceptions, entirely marine. The depth of the sea generally does not appear to have been very great, getting shallower when the upper greensand was deposited. The three subdivisions contain many species peculiar to each, while some ranged upwards into the white chalk. The gault has many forms peculiar to it, differing from those of the lower greensand below and the upper greensand above. In many cases both these deposits are singularly destitute of fossils. The indications of neighbouring land are certainly more numerous in the lower greensand; thus, in the Kentish rag near Maidstone some fine remains of the gigantic terrestrial lizard of the wealden, the iguanodon, have been discovered, and traces of drift-wood and coniferous plants have been met with there and elsewhere. Mr. Bensted's quarry is well worth a visit, as it exhibits a good section of the rag. To him is due the discovery of the iguanodon there, and a fine carapace of a marine turtle.

The lower greensand and gault contain some distinctive forms of Cephalopoda, as the *Ancyloceras grandis*, *Crioceras Bowerbankii*, numerous species of Hamites, which are not present in the upper white chalk. Some of these, especially the former, were of gigantic size. Some curious forms of Rudistes, *e.g.*, *Diceras*, and Hippurites occur in the lower greensand. Ammonites and Belemnites abound, and many species of univalve and bivalve shells; the former especially in the gault and lower greensand. There are also many Echinoderms, a few star-fish, crabs, and, in certain localities, a considerable abundance of sponges, a few of which are peculiar to the lower cretaceous group, presenting singular forms. Small crustacea are not unfrequent, especially at Atherfield, where one particular stratum contains them in such numbers that it has been termed the "lobster bed." This locality must be visited by those who wish to understand the general characters of the lower greensand in that part of England; the section being a great type section, the finest in the country, and abounds in rare and beautiful fossils. Foreign geologists have denominated this part of the series "Neocomian." It is much more largely developed on the Continent, though it can be well studied in the Isle of Wight, where, in the lower part, the nature and relations of

its identity with the same group in Switzerland has been so well established. The cliffs are about one hundred and fifty feet in height, and the total thickness of the lower cretaceous series here exposed is nearly eight hundred and fifty feet. The lower greensand has been divided into numerous beds, which are severally distinguished by peculiar sets of fossils. Thus the *Perna mulleti*, small lobsters (*Meyeria magna*), *Gervillia anceps*, and groups of *Terebratulæ* characterize different bands in succession.

Farringdon, in Berkshire, is another interesting locality belonging to the lower division, possessing a somewhat peculiar lithological aspect, a sandy conglomerate highly charged with iron, with occasional masses of harder stone, the greater part of which is composed of entire and broken shells, and corals in great abundance and variety, the most remarkable being a poriferous cup-shaped zoophyte or sponge, the *Cheniendopora fungiformis*. There are many other interesting forms of sponges and corals, and in a short time a good characteristic suite may be collected. The position of the greensand at Blackdown being now generally believed to be immediately below the gault, the fossils of that interesting locality may be properly considered here. The fossiliferous beds are confined to a thickness of twenty feet, and abound in marine shells in a beautiful state of preservation, which being, for the most part, converted into chalcedony, has greatly tended to this result. The bivalves preponderate, but univalves are sufficiently abundant. A fine species of star-fish has been obtained from these pits. Siphonia pyriformis, a spongiform zoophyte with the head, stem, and root attached, occurs here, but the Spongiadæ are not generically numerous. Some of the species are peculiar to the district, but others have a wider range, being present in the lower greensand and passing upwards into the gault and upper greensand.

The gault, a local name in Cambridgeshire for the blue clay which divides the lower from the upper greensand, averages about two hundred feet thick, and contains in places an abundance of organic remains, chiefly marine shells, small crustacea, a few corals, and occasionally drift-wood, generally bored by teredo. Many of these are characteristic of this formation, such as we might expect to occur in the altered mineral condition of the waters, charged with a muddy sediment, so different from that of the superior and inferior green and ferruginous sands. Peculiar forms of ammonites, hamites, and belemnites characterize this argillaceous deposit, and are remarkable for the beautiful pearly display of colours which they so often exhibit, and this renders them especially attractive to collectors. The vicinity of Folkestone, in Kent, is perhaps the most prolific, and in the Isle of Wight the best sections are exposed.

The upper greensand generally does not exceed one hundred feet, but it is often less than two, especially at Cambridge, where the extensive excavations for the phosphatic nodules, before alluded to, have brought to light a more extensive and interesting series of fossils than in any other locality in the British Isles. The shells, it is true, are mostly in the form of casts; but here, for the first time in the cretaceous group, we have several bones of a swimming bird, and also of a whale, consisting of a vertebra and other bones. No cetacean has ever yet been previously found in any older formation, and in none of the newer, until we reach a more comparatively recent period. Associated with these are remains of ichthyosaurus, pterodactyle (a flying lizard), and the gigantic polyptychodon, which also occurs in the lower greensand. There are various species of fish, chiefly teeth, bones, and vertebra of the shark tribe, the most singular being the curious genera Edaphodon and Chimera. Small turtles and crustacea are

occasionally met with in this rich deposit, valuable alike to the palæontologist and agriculturist. The finest collection is to be seen in the Woodwardian Museum at Cambridge, which contains from this, as well as other strata, many unique and beautifully preserved specimens, and, together with the British Museum and the Museum of Practical Geology, are national collections of which science may be justly proud. These important discoveries at Cambridge, and the association of marine mammalia and birds with ichthyosaurus and pterodactyle, shows us, as Sir C. Lyell has justly remarked, that geologists should exercise great caution in forming conclusions from mere negative evidence alone as to the absence of certain forms of animal life, whether fluviatile, terrestrial, or marine, in any particular deposit; and while every year adds to our knowledge of the ancient world, it is unwise to assume that one order either preceded or took the place of another at any given period. The unexpected disclosure of mammalian remains in the Purbeck formation, in the epoch more immediately preceding the cretaceous, strengthens this assertion, and though we undoubtedly know much of the history of the past, especially of late years, we may feel tolerably certain that there is a great deal still to be revealed, and that we are only, as it were, on the threshold of geological discovery, the limits of which it would be impossible as yet to define. In calling attention to the more interesting localities in the greensand, we have seen how certain areas are rich in genera and species, while elsewhere the beds are comparatively barren. This equally holds good in the present day, both on the land and in the water, where the fauna and flora are more or less prolific, according to climatal or other essential conditions, which must ever influence all classes of the animal and vegetable kingdoms; and, in some cases, there might be an almost total absence or great scarcity of life.

As bearing upon this subject, two more highly fossiliferous places must be mentioned, viz., Chute Farm, near Longleat, and Warminster in Wiltshire. The former has been long famous for a great variety of small shells and corals in a fine state of preservation; so numerous, indeed, were they that the geologist who first detected them remarked that it seemed as if a choice cabinet collection had been purposely deposited there. The rarest species is the *Lyra Meadie*, a curious brachiopod seldom met with in England, but not uncommon in France. At Warminster shells are by no means frequent, but it is singularly rich in the remains of zoophytes, among which the genus *Polypothecia* is the most common. They are porous, spongy bodies, having numerous tubular cavities in the interior, which are well exposed when cut across or lengthwise; some of them resemble a cucumber in shape, others terminate in a lobed bulb or head, varying from two to eight or more lobes, the number serving to distinguish the different species. The stems are of a moderate thickness, and though the roots are rarely found in juxtaposition, they were probably attached by this means to the rocks on which they grew. The cucumber-shaped species also occurs in the chalk, chiefly in flint, but the greensand is the principal depository of these singular zoophytes. With these are associated several other sponges, chiefly cup-shaped, some of which have long stems attached; they present much elegance of form, and must have been striking objects when living in their native element. The Farringdon cup sponges are much smaller, and belong to distinct genera.

Such, then, is a brief sketch of the geological history of the cretaceous period, the whole of which, though properly linked together by a similarity of fossil contents, presents also many organic changes, by the dying out of some species and the appearance of new ones; as we pass from the lower

to the higher series, although there are a few traces of some forms of animal life which flourished in the preceding oolitic, such as the iguanodon, icthyosaurus, and pterodactyle; the rest are entirely distinct from it, having a character peculiar to themselves, and though approaching to those of later date, still constitute a distinctive and well-marked feature between the oolitic and the tertiary epochs. It is worthy of remark, that those curious and beautiful cephalopodous molluscs, the belemnite, scaphite, hamite, ammonite, and other allied genera, are not found in any formation newer than the chalk. The lithological changes, too, which marked the entire group, are equally remarkable, and the differences between the greensand and the chalk have been already referred to. These zoological and mineralogical facts all indicate vast periods of time, during which such mutations were effected, shallow or moderately deep seas gradually becoming deeper, and the coast-line consequently more distant. Such physical alternations would be quite sufficient to account for any corresponding amount of variation in the marine fauna of the different groups, and the increasing scarcity of terrestrial remains. The geologist is then able to learn something, at least, of the past creation, and though many apparently well-founded theories will have to be modified or entirely eradicated, there are certain facts and conclusions which are as firm and immovable as the very rocks themselves, whose history he thus profitably endeavours to elucidate.

P. B. Brodie, M.A., F.G.S.

Rowington Vicarage.

RUHMKORFF'S COIL-MACHINE.

If the two ends of a galvanic battery be connected by means of a moderately long copper conducting wire, a current of positive electricity will pass from the copper end of the battery along the wire, while a current of negative electricity passes from the zinc end, along the wire in an opposite direction.

To avoid prolixity, however, it is customary to speak of the positive current alone, that is, the current which passes from the copper to the zinc, through the conducting wire; the opposite current being always understood to exist, since it invariably accompanies the former.

A wire through which a current is thus passing possesses certain remarkable properties, which are capable of experimental demonstration, by means of apparatus of a very simple nature.

Let P N (Fig. 1) be a fine copper wire, whose end P is attached to the copper element of a battery of two or three cells (or pairs of elements), while the other extremity N is connected with the zinc element. On placing clean soft iron filings in proximity to this wire, they will be attracted and will cluster round the wire as shown at *a*. From

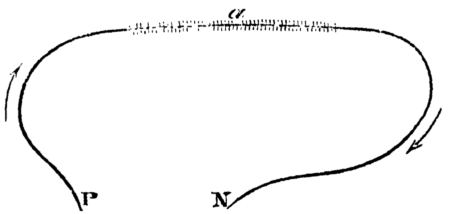
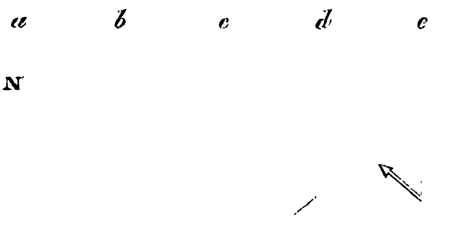


Fig. 1.

this it will be seen that the copper wire is temporarily endowed with magnetic properties; but only temporarily, for the moment the connection of the wire with the battery is broken, the iron filings drop off, and are not again attracted till the connection is renewed.

Exp. 2. Again, take a small, delicately-mounted magnetic needle, and let it assume its natural position of rest, which will of course be nearly due north and south, as at *a* (Fig. 2). If we now bring immediately *over*



it the copper wire, c z, connected with the copper and zinc ends of a battery, the current therefore passing in a direction from c to z, it will be seen that the needle is instantly deflected to the left, more or less according to the strength of the current and the proximity of the wire to the needle (*b*, Fig. 2). On removing the wire, the needle returns to its natural position.

Now place the wire *under* the needle as at *c*: the needle is again deflected, but in a direction the opposite of that which it took in the last instance.

Let the wire be removed, and the needle allowed once more to assume its original position; turn the wire about so that the portion brought to act on the needle shall offer a current flowing in the contrary direction as at *d* and *e*. On placing the wire, first above and then below the needle, deflections will occur in directions opposite to those of the two former.

From this it will be seen that we reverse the deflections of the needle, either by reversing the current alone, or by altering its position alone, while if we make both changes simultaneously, the one neutralizes the other, and the deflection remains the same.

* The wire is placed on the wrong side of the needle at *b* and *d* in the figure. The reader is requested to correct this error, remembering that the wire is to be placed *above* the needle in these two instances, and not *below*, as in the engraving.

Unless the battery be tolerably powerful, the influence of the single wire on the needle will be small. We will now show how a single cell, say of a Daniell's battery, such as is described in RECREATIVE SCIENCE, vol. iii. p. 23, may be made to produce a much more marked result.

Exp. 3. Take several yards of copper wire, previously covered with silk or cotton, and form it into a coil as shown in Fig. 3, *a b*,

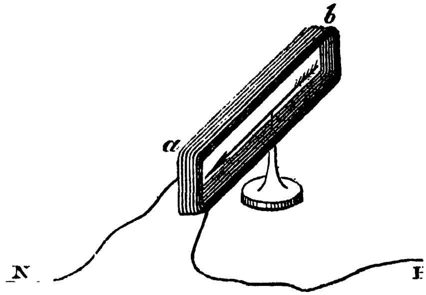


FIG. 3.

and sufficiently large to admit of the needle's turning freely within it. Mount the needle on a point as indicated in the figure, and connect the wires P and N with the battery; the moment connection is made, a deflection of the needle takes place, and with very much greater force than when a single wire only was made to act on it. For, be it observed, all the wires above and below the needle act with their united force to cause the deflection. It has already been demonstrated that a current in a given direction *above* the needle is the same in effect as a current in the opposite direction *below* it. Now, the simple bending of the wire back upon itself is all that is necessary to produce this opposite current; and hence the combined effect of the coils is to impel the needle in one and the same direction.

A coil and needle thus mounted constitute a *galvanometer*. It is not very sensitive, when constructed in this simple manner, but will answer sufficientiy well for our present purpose. Whenever it is about to be used as a galvanometer, it must be placed in such a position as that the needle shall lie straight between the coils, and as the needle is mounted on point, and cannot be controlled, the only way to give it the desired position is to move the coils about till they cover the needle, and the needle lies as above directed.

Thus far we have shown the action of the conducting wire upon a magnetic needle, and the results at which we have arrived are exceedingly important, inasmuch as they enable us to determine (1) when a current exists in a wire, and (2) the direction in which that current is moving.

It is customary with most persons to assist the memory in retaining a distinct notion of the movements of a needle about a wire, by means of some artifice. The following, amongst others, is a very good one:—Suppose yourself standing before the face of a clock with your finger stretched out to touch its centre. Imagine a current of electricity to pass from your body along your arm as the conductor, and through the clock face to the opposite side; *then the effect of that current upon the north pole of the needle will be to impel it in the same direction as the hands move,* whether the needle be placed above, below, or on either side of the wire.

Keeping this little formula in mind, we can, by placing a delicately suspended magnetic needle near a wire, immediately tell if a current is passing along it; and by noting the direction in which the needle is deflected, we can determine the *direction* of the current.

Armed with these new powers of observation, we may advance a step further, and ascertain what is the effect of a current upon other bodies *not magnetic*, like the needle.

Let a straight wire (A B, Fig. 4) be connected, by means of solder or binding screws, to the ends of the coils of the galvanometer. If the coils be now placed so as to cover

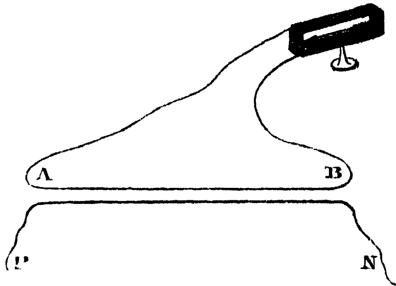


FIG. 4.

the needle, and the apparatus be then left to itself, all will remain quiescent. This being noted, we will now try the effect of bringing a conducting wire in proximity to the wire A B. Let P N be such a wire, of which either end (say P) may be attached to the battery. Of course, so long as the other end is detached, no current passes along the wire. And that we may be at perfect liberty to observe the galvanometer, place two or three thin pieces of cork between the wires A B and P N, and bind them steadily together with a thread; by this means they will be kept in *proximity* without coming into contact, and will require no further care on the part of the experimenter. Now keep your eye on the galvanometer, while you bring the extremity N in contact with the zinc element of the battery. You will perceive that the needle is deflected for a moment, and then returns to its position of rest in the centre of the coil. Watch again, as you detach the extremity N from the battery, the needle is again deflected for a moment, but in a direction the opposite of that it took before, and then returns once more to its position of rest.

Hence it appears that the *primary* current through P N, at the moment of its formation, possesses the remarkable power of *inducing*

a *momentary secondary* current in the wire A B in a certain direction; and, at the moment of its destruction, the power of inducing a similar current, but in the opposite direction; and, by applying the formula before given, it will be found that, on *making* the contact, the induced current is *contrary* to the primary; while, on *breaking* the contact, the induced current is *in the same direction* with it.

Here, then, we have a first glance at the fundamental principle on which all coil-machines are constructed, viz., that when a wire through which a current is passing is brought into proximity to a *closed conductor*, a momentary current is induced or set up in the latter, every time the primary current is interrupted or renewed, the secondary currents being respectively in opposite directions.

The conductor through which this secondary current circulates is called "*closed*," because, as will be seen, the wire is continuous, the ends being soldered, or otherwise connected together.

On breaking and renewing contact, a very minute spark may be seen at the point of junction, and this is all that is as yet directly manifest to the senses. We must increase the power of the apparatus many thousand-fold before we can produce shocks, or make any of the experiments which have rendered the coil-machine so famous. How this is accomplished, we will now unfold.

In Fig. 5, P N is the primary conductor. It is coiled round a ruler from *c* to *d*, and then by proceeding from *d* back again to *c*, another series of coils is superposed upon it. The wire should be about the thickness of ordinary bell-wire, and completely covered with cotton or silk; lateral currents are thereby prevented, and a continuous current from P to N is secured. This coil is called the *primary coil*, and its current, the *primary current*. In like manner, the *secondary coil* is constructed, but is of larger diameter, though of much finer wire; through this, the *secondary current* circulates, as shown at A B. If we now place the primary coil

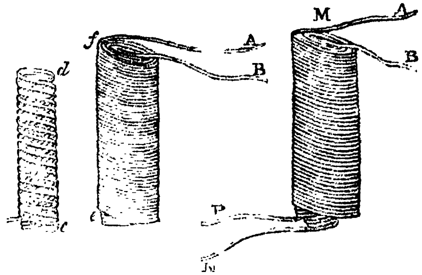


FIG. 5.

within the secondary as at M, and connect the extremities A and B with the galvanometer, while N is connected with the zinc element of the battery, we shall find, on bringing P into contact with the copper element, that the needle is deflected much more vigorously than in our former experiment; and, on breaking contact again, that an opposite deflection takes place with equal vigour, as might have been predicted. The spark will also be larger and brighter at the point of junction of the primary wire.

Thus we have given our elementary apparatus a marked increase of power, and this increase will be found the greater, as the number of coils in the *secondary* current is augmented. To increase it yet more, prepare a faggot of slight iron wire cut into pieces about the length of the primary coil, that is, the right line extending from *c* to *d*, and bound together with thread. When this is thrust into the centre of the primary coil, all the sensible effects of the secondary coil are prodigiously increased, and if the galvanometer be removed, and the extremities of the secondary coil, P N, be held in the moistened hands, a slight shock will now be distinctly felt.

Here, then, we have the essential elements of all coil-machines, viz., the primary coil, the secondary coil, and the bundle of iron

through the atmosphere, as when the ends D and E are brought into proximity, but not into contact, have the appearance of a continuous stream of light.

It will be seen, therefore, that the wires D and E are now endowed with very extraordinary properties; and it is by connecting them with the various kinds of apparatus which have been contrived with a view to exhibit the peculiarities of electric light, that all those brilliant effects are produced, which, in the various capitals of Europe—though nowhere perhaps more successfully than at our own Polytechnic—are now astonishing and delighting the thousands who flock to witness them.

To enter upon a description of these articles of apparatus would be out of the question in this paper. We must endeavour to furnish descriptions occasionally, as space will permit, of such as may be made by the amateur, or are attended with any peculiar interest. A detailed description of the machine, and the principle on which its amazing power depends, was the sole object of our present endeavour.

RICHARD BITHELL.

ASTRONOMICAL OBSERVATIONS FOR SEPTEMBER, 1861.

THE Sun is in the constellation Virgo, and therefore north of the equator, until the morning of the 23rd, when he enters Libra, and is south of the equator. He rises in London on the 1st at 5h. 13m., on the 10th at 5h. 28m., on the 20th at 5h. 41m., and on the 30th at 6h. 0m.; setting on the 1st at 6h. 45m., on the 10th at 6h. 25m., on the 20th at 6h. 2m., and on the 30th at 5h. 39m. He is above the horizon in London on the 1st, 13h. 32m., and on the 30th, 11h. 39m.

He rises in Edinburgh on the 2nd at 5h. 8m., and on the 22nd at 5h. 48m.; setting at Edinburgh on the 3rd at 6h. 47m., and on the 23rd at 5h. 54m.

He rises in Dublin at 5h. 17m. on the 5th, at 5h. 35m. on the 15th, and at 5h. 57m. on the 27th; setting in Dublin at 6h. 36m. on the 6th, at 6h. 12m. on the 16th, and at 5h. 46m. on the 28th.

The Sun is on the meridian in London on the 3rd at 11h. 59m. 10s.; on the 18th at 11h. 54m. 2s., and on the 28th at 11h. 50m. 35s.

The equation of time is on the 3rd, 0m. 50s., on the 18th, 5m. 58s., and on the 28th, 9m. 52s. addative.

Twilight ends on the 4th at 10h. 28m., and on the 28th at 9h. 14m.

The Moon is new on the 4th at 10h. 12m. p.m.

Full Moon on the 19th at 2h. 1m. a.m.

She is nearest to the earth on the 7th, and farthest removed on the 22nd.

Mercury is in the constellation of Leo at the commencement of the month, and in that of Virgo at the close. He is unfavourably situated for observation owing to his proximity to the Sun. He rises on the 3rd at 5h. 6m. a.m., and on the 28th at 7h. 40m. a.m.; setting on the 3rd at 6h. 48m. p.m., and on the 28th at 6h. 5m. p.m. His diameter is 4¾" during the month.

Venus is in Virgo at the beginning, and in Libra at the close of the month; unfavourably situated for observation, being too near the Sun. She rises on the 3rd at 8h. 10m. a.m., and on the 28th at 9h. 30m. a.m.; setting on the 3rd at 7h. 30m. p.m., and on the 28th at 6h. 44m. p.m. Her diameter is 12" on the 1st, and 13" on the 25th.

Mars is in Leo at the commencement of the month, and in Virgo at the close. He is invisible. His diameter is 3¼".

Jupiter is in the constellation of Leo during the month; he is invisible until nearly its close. He rises on the 3rd at 4h. 59m. a.m., and on the 28th at 3h. 52m. a.m.; setting on the 3rd at 6h. 43m. p.m., and on the 28th at 5h. 14m. p.m. His diameter throughout the month is 29".

Saturn is in Leo, and invisible during the month.

Uranus is in the constellation Taurus, he rises on the 3rd at 9h. 57m. p.m., and on the 28th at 8h. 18m. p.m.; setting on the 3rd at 2h. 21m. p.m., and on the 28th at 12h. 44m. p.m. Owing to the five large planets being all situated close to the Sun, Uranus is the only planet visible.

Eclipses of Jupiter's Satellites.—None visible during September.

Occultation of Stars by the Moon.—September 14th, π Capricorni (5th magnitude) disappears at 8h. 3m. p.m., and reappears at 9h. 14m. p.m. September 14th, ρ Capricorni (5th magnitude) disappears at 9h. 17m. p.m., and reappears at 10h. 30m. p.m.

The variable star Algol attains its least light during the evening on the 4th at 10h. 1m., on the 24th at 11h. 41m., and on the 27th at 8h. 30m.

Stars on the Meridian.—On the 3rd, α Aquilæ souths at 8h. 51m. 12s. p.m. On the 3rd, α Pegasi souths at 12h. 6m. 26s. a.m. On the 3rd, Fomahault souths at 11h. 57m. 40s. p.m. On the 4th, β Aquilæ souths at 8h. 52m. 44s. p.m. On the 6th, α Cygni souths at 9h. 32m. 56s. p.m. On the 12th, β Aquarii souths at 9h. 56m. 47s. p.m. On the 13th, ϵ Pegasi souths at 10h. 5m. 56s. p.m. On the 13t Fomahault souths at 11h. 18m. 21s. p.m. On the 13th, α Pegasi souths at 11h. 26m. 11s. p.m. On the 23rd, α Aquarii souths at 9h. 47m. 51s. p.m. On the 28th, Fomahault souths at 10h. 19m. 22s. p.m. On the 28th, α Pegasi souths at 10h. 27m. 13s. p.m. On the 28th, α Andromedæ souths at 11h. 30m. 25s. p.m.

E. J. LOWE.

METEOROLOGY OF SEPTEMBER.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

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Year.	Mean elastic force of vapour, or the pressure due to the water contained in the air.	Mean pressure of dry air, or the pressure due to the gases of the air.	Mean weight of vapour in a cubic foot of air.	Mean degree of humidity 100 = complete saturation.	Mean quantity of water in a vertical column of the atmosphere.	Weight of a cubic foot of air.
	Of an inch.	Inches.	Grs.		Inches.	Grs.
1848	0·389	29·484	4·1	0·76	5·4	530
1849	0·386	29·413	5·0	0·86	6·3	531
1850	0·366	29·601	4·2	0·86	6·1	535
1851	0·350	29·682	4·0	0·81	4·8	536
1852	0·365	29·411	4·1	0·82	5·0	531
1853	0·343	29·432	3·9	0·82	4·7	534
1854	0·391	29·585	4·4	0·83	5·4	532
1855	0·376	29·594	4·3	0·82	5·2	533
1856	0·329	29·286	3·7	0·78	4·5	533
1857	0·402	29·357	4·5	0·82	5·6	531
1858	0·374	29·417	4·2	0·76	5·2	532
1859	0·355	29·301	4·0	0·79	4·9	532
1860	0·294	29·463	3 3	0·70	4·1	538
Mean	0·363	29·470	4·1	0.80	5·2	533

The mean elastic force of vapour, *i. e.*, the pressure of the barometer due to the water contained in the air, is for September of the past thirteen years 0·363 of an inch; ranging between 0·294 of an inch in 1860, and 0·402 of an inch in 1857—a difference of 0·108 of an inch (or over a tenth of an inch).

The mean pressure of dry air, or the pressure due to the gases of the atmosphere at the height of 174 feet above the mean sea-level, for September of the last thirteen years, is 29·470 inches; ranging between 29·286 inches in 1856, and 29·682 inches in 1851—a difference of 0·396, or nearly four-tenths of an inch.

The mean weight of vapour in a cubic foot of air for September, during the past thirteen years, is 4·1 grains; ranging between 3 3 grains in 1860, and 5·0 grains in 1849—a difference of 1·7 grains.

The mean degree of humidity (complete saturation being represented by 1·00) for September, during the past thirteen years, is 0·80°; ranging between 0·70° in 1860, and 0·86° in 1849 and 1850—a difference of 0·16°.

The whole amount of water in a vertical column of the atmosphere for September during the past thirteen years is 5·2 inches; ranging between 4·1 inches in 1860, and 6·3 inches in 1849—a difference of 2·2 inches (or two and a quarter inches).

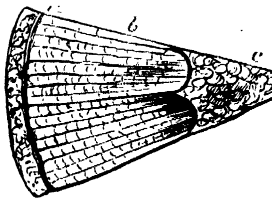
The mean weight of a cubic foot of air for September, during the past thirteen years, is 533 grains; ranging between 530 grains in 1848, and 538 grains in 1860—a difference of 8 grains.

E. J. Lowe.

THE MICROSCOPIC OBSERVER. SEPTEMBER.

VEGETABLE ANATOMY.—At this season of the year the microscopist may vary the round of his studies by making sections of vegetable structures, and the nearly ripe branches of exogenous trees will be found eminently suitable for the display of the details of the organism by which the living fabric has been built up. Hooke was the first accurate observer of the vascular system of plants, and among the first of his researches he numbered, in a line the eighteenth of an inch in length, 150,000 ducts in a cross section of a piece of charcoal. Hooke next experimented on decayed wood, and then on wood that had become fossilised, and in each case he found that the anatomical structure was but slightly damaged, and the intimate structure of the fabric was still traceable. In Dicotyledons the development of the fibro-vascular bundles is the most perfect and extensive in development, and the cambium layer from which the wood of the season is deposited, is easily determined by means of a cross section, as are also the spiral vessels, the ducts, the woody fibre, and the cellular structures of the bark.

When a cross section of a tree or plant is viewed by the naked eye, it is seen to consist of *three parts*,

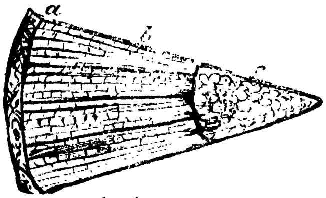


Section of Apple.

the *pith*, *c*, the *woody texture*, *b*, and the *bark*, *a*. The size of the pith varies in different trees, in some being from two to three inches in diameter, and in others from five to six; and of all plants, herbs and shrubs have the greatest quantity of pith in proportion to the other parts. The pith is found to consist entirely of cellular tissue, and the cells are of various sizes. Those of the thistle appear under the microscope as large as the cells of a honey-comb; those of plum, wormwood, and sumach, are smaller, and the cells in the pith of the apple and pear are still less; while those of the oak are so minute that one hundred only equal in size a single cell of the pith of the thistle. The size of the cells is not proportioned to that of the pith, for in the plum, the pith of which is less than that of the pear, the cells are from four to five times as large; and the cells of the pith of the hazel, which is three times smaller than that of the holly, are ten times greater than those in the holly.

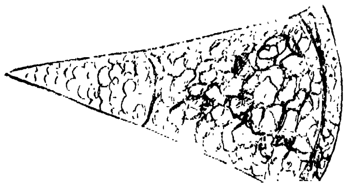
The second portion of the plant is the wood or woody texture; it encircles the pith, and consists, as already stated, of two parts; *bundles of tubes*, bound together by *cellular tissue*. In most trees the vessels are numerous, and when beheld in a cross section are

seen to be disposed around the pith in concentric layers, and rays of cellular tissue to run from the pith to the bark, diverging like the spokes of a wheel from the axle. This arrangement is seen in the drawings, which represent cross sections of branches three years old. The insertions of the cellular tissue are indicated by the lines that run from the pith outward like the sticks of a fan. These inser-

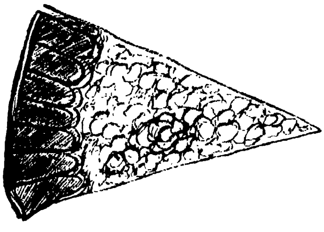


Section of Pear.

tions of tissue pass through the substance of the wood, and are much diversified in size in different woods. In pine they are of a medium size, and in pear and holly extremely small, but no uniformity in this respect is observed in the same wood, for in holly, hazel, pear, plum, and oak, they are very unequal; some in the holly being four or five times thicker than the rest; while in the plum many are six or seven times greater than others, and in the oak ten times at the least. In trees like the palm, the vessels of



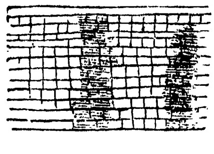
Section of Gooseberry.



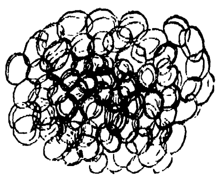
Section of Rose.

the vascular system are by no means so numerous as in other woods, and being necessarily placed at a greater distance from each other, do not present that symmetrical radiated appearance which sections of common trees exhibit; but the bundles of tubes are promiscuously scattered amid the cellular tissue. In the case of herbaceous plants, to a great extent, the cellular tissue forms the chief portion of the plant, and the vessels of the vascular system are but few in number. When a cross section is viewed they are seen in bundles dispersed through the cellular tissue, at considerable distances from each other; they are, however, symmetrically arranged, and in the same species of plant always maintain the same position; the vessels being situated at the same relative distance from each other and from the centre of the pith.

The bark which encircles the wood is composed of

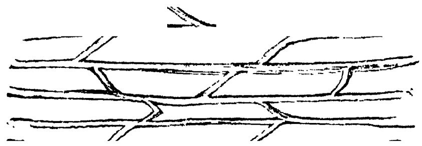


Deal.



Elder Pith.

two parts, the *true bark* and the *outer* skin which covers it; both of which are made up of vessels and cellular tissue like the wood. The tubes or vessels belonging to the bark are denominated *proper vessels*, and are filled with the fluids peculiar to this portion of the plant. In some herbs these vessels often cluster together in separate columns, and are arranged in a circular form; in others they present a radiated appearance. In trees, the tubes are more distinct, and assume a greater regularity in their disposition. They



Inner Skin of Onion.

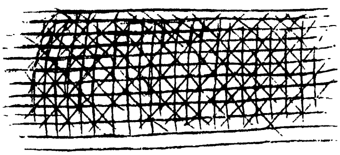
are usually found near the inner margin of the bark, next to the wood, and when viewed in the direction of their length, present an appearance like network. In the bark the vessels are found to possess different sizes as well as in the wood. In the pine, for instance, the tubes containing the turpentine exceed the common sap-vessels in magnitude by three or four hundred times, and are surrounded by a ring of smaller tubes.

The vessels containing the fluids peculiar to the bark are often found dispersed through the wood from the bark to the pith. Thus, in the fir and pine, the turpentine and gum-tubes are seen in the wood, arranged in a circle around the centre, in nearly the same way as the sap-vessels. These vessels are regarded by naturalists as having once belonged to the bark, which, changing into wood by the natural growth of the tree, in the manner soon to be explained, and becoming encased annually in successive layers of wood, was gradually removed farther and farther from the exterior surface of the tree. The skin or rind of the bark when taken from young shoots, appears in most cases to consist of a single layer, but in many kinds of wood it is found to be complex; as in the case of the white birch, in which it consists of distinct layers that are

readily separated from each other, amounting not unfrequently to sixteen or eighteen in number.

In some trees the layers are still more numerous, for Ulloa speaks of a tree in Peru, from the rind of which he peeled off no less than *one hundred and fifty* envelopes; when, tired of his task, he refrained from counting the remainder, as the layers he had detached did not constitute more than half the thickness of the rind.

THE GROWTH OF TREES.—Commencing on the outside of the tree, the exterior covering is the skin or rind, consisting, as has already been stated, of several distinct layers. Beneath this is the bark, composed of cellular tissue and bundles of tubes or vessels running longitudinally; and at first parallel to each other. When a cross section is made of a shoot of a year old, only a single ring of vessels, or cluster of vessels arranged in a circle, is found surrounding the wood, and this, with the tissue in which they are enveloped, constitutes the bark of the plant. During the second year, a new layer of bark with its vessels and tissue grows within the former, and next



Outer Skin of Onion.

to the wood; and every successive year a new layer of bark with its vessels and tissue grows within the former, and next to the wood; and every successive year a new layer of bark is thus added: the entire thickness of this envelope being constituted of a series of layers, increasing in number *from within*.

Next to the bark, the wood is found consisting likewise, as we have seen, of vessels and cellular tissue, and the cross section of a plant or shoot of one year's growth exhibits the wood arranged around the pith, and composed of a ring of vessels banded together by cellular tissue. The growth of the succeeding year gives rise to a new ring of vessels outside of the first ring, and beyond this second ring a third circle of vessels appears during the third year. The wood of the tree, therefore, increases from *within outwards*, in a direction contrary to the growth of the bark; and consists of a series of rings, equal in number to the years indicating the age of the tree. The outer ring is whiter and more full of sap than the rest, and has received from this circumstance the name of *sap-wood.* In the last annual layer of wood and bark, by which the trunk is increased in size, the sap-wood and new bark are in contact; but the layer of the next year pushes up between, and separates them by its entire thickness. Every year a new layer is thus interposed in the midst of the others, the last formed layers of wood and bark touching each other, while the oldest are the most widely separated; the first ring of wood directly inclosing the pith, and the first envelope of bark constituting the outer surface.

The layers of wood annually formed are not simple in their structure, but are each composed of a great number of other layers. These delicate membranes can be distinctly perceived in the oak by the aid of a common magnifying glass, when the branch or shoot is cut obliquely. By macerating the rings of wood in water, Du Hamel was enabled to separate an annual layer into a vast number of primary layers, which were thinner than the finest paper; and he afterwards discovered by experiment that these primary layers, constituting an annual ring, were formed in *succession*, during the period of growth and vegetation, in the year to which the ring belonged. So that however curious it may seem, it is still true, that not only does the relative thickness of each annual ring indicate the comparative fruitfulness of every year of the existence of the tree, but each of the primary layers composing the several rings tells, by its thickness, of the comparative vegetative energy of each week and day of the particular season to which it belongs; and thus every tree becomes a record of the fertility of that period of time during which it lived and flourished. The branch possesses exactly the same structure as the trunk, it is, in fact, a secondary trunk.

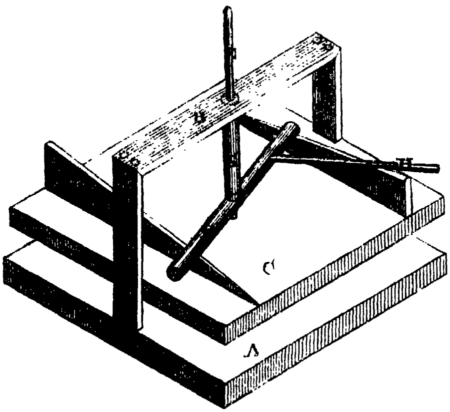
OUTDOOR STUDIES.—*Chara gracilis* is now in its best condition for microscopic purposes. Among the plants of the field now in flower, and useful for special purposes in the observation of various details of vegetable physiology, the following demand enumeration:—*Salicornia radicans*, sea-shore; *Parnassia palustris*, bogs; *Alisma repens*, lakes; *Polygonium Hydropiper* and *minus*, wet hollows; *Stachys germanica*, chalk hills and sandy banks; *Bidens cernua*, ditches. The insects most likely to be met with are the following:—*Helophorus fennicus*, *Proscarabæus autumnalis*, *Gomphocerus rufus*, *Colias edusa*, and *chrysotheme*, *Chlenius vestitus*, *Acridia viridissima*, *Acherontia atropos.*

Mr. Noteworthy's Corner.

ATTEMPTS TO PHOTOGRAPH THE COMET OF JULY, 1861.—As far as we have been able to learn (says a writer in the *London Review*), these were, without exception, failures. An exposure of the sensitive plate to its luminous image, in a telescope, for 120 times as long as sufficed to depict the comet of 1858, entirely failed with the present one in giving any trace of an image, thus proving that there is an essential difference between the two bodies in physical constitution, inasmuch as whilst the luminous rays emitted by them were of almost equal intensities, the actinic rays were almost entirely absent in the light from the present comet. It resisted even the powerful photographic arrangements of Mr. Warren De La Rue. After three minutes' exposure in the focus of his 13-inch reflector the comet had left no impression upon a sensitized collodion plate, although a neighbouring star, π Ursæ Majoris—close to which the comet passed on the night of the 2nd (Tuesday)—left its impression twice over,

from a slight disturbance of the instrument. Mr. De la Rue also, at that time, fastened a portrait camera upon the tube of his telescope, and, with the clock-motion in action, exposed a collodion plate for fifteen minutes to the open view of the comet without any other effect than the general blackening of the surface by the sky-light, accompanied with impressions of fixed stars in the neighbourhood. He mentions, in a private letter, that he intended to have "a good search for the nucleus among the stars depicted," adding that he was quite struck by the want of actinic force in its image.

A Portable Press.—From the interest Mr. Noteworthy takes in giving publicity to simple ideas and things, for the good of the readers of Recreative Science, I have been induced to submit an illustration with explanation of a simple and portable press, which may be used for a great many purposes connected with philosophical amusements. The idea suggested itself



to me after a great number of experiments in trying to obtain a parallel and equal pressure without a screw. The object I required was a simple printing-press, by which I could take impressions of any wood-engravings, the results of attempts at beguiling leisure-hours. Living six miles from a printer I have no opportunity, without inconvenience, of his assistance, hence the necessity for supplying my own wants. I am not acquainted with a printing-press beyond reading about it, consequently, if the terms applied to the various parts be incorrect, it must be attributed to my ignorance. I have not sent a drawing of my forme, tympan, and frisket, which are simple and moveable on the bed. The tympan and frisket are as one part, the latter being two elastic webs placed parallel to each other on the face of the tympan, and under the webs slide two strips of cardboard, which keep the paper on the tympan. The back of the tympan is moveable, which enables me to pad or reduce its thickness to suit requirements. The platen, c, is kept close to the collar by means of two springs or two pieces of elastic web. When a pull is effected, the lever, f, travelling up the inclined planes, d d, forces them and the platen down, and by reversing the pull, the springs recoil, carrying the platen back to its highest place, which is when the lever is parallel to the planes, or between them. The height of the planes gives the amount of pressure. I am not aware that this kind of press has been tried; it is quite new to me, and its cost only being for material, the workmanship being my own. I made a press on the principles of a lever of the second order, and the platen descended parallel, but without the press being fixed, the pressure on the platen was materially diminished. The inclined plane press can be moved to suit convenience, and its pressure maintained for any time by simply inserting a stop in the top of the platen to keep the lever from returning.—James Saxty, *Market Lavington*.

Habits of Wasps.—Mr. R. L. Edgeworth says, in his interesting paper on wasps, that they do not destroy bees, and that from one solitary experiment of introducing a bee into a wasp's hive he deduces that wasps never attack or destroy beehives. It is a pity to make such dogmatical deductions, without keeping bees as well as wasps, and watching the results. I may mention, for the defence of "the popular creed," that so far as making the attempt goes, I have seen bees (which I keep under most favourable circumstances for their protection), attacked at their own hive-door, while the hive was in the most flourishing order, and when the bees were most numerous. Indeed, I have seen and admired the bravery of a single wasp coming to the hive when I was feeding the bees, and stealing a dip at the sweets, challenging to single combat the first bee who came near him, grapple with it, roll struggling over the edge of the hive-board, fly off with it fighting in the air, where, by his superior activity, he got an opportunity for a fatal sting, and return triumphantly alone, doing next minute the same thing, and this half-a-dozen times in succession. It was only when two or three bees got on him at once that he was mastered, and received his own *coup de grace*, not without a most valiant defence against so great odds. It is a beautiful sight to see the wonderful fencing a wasp will employ to keep his assailants at arm's length, and the gymnastic feats he will perform with lightning speed, while the slower bee is astonished to grapple empty air when dashing at the place his yellow foe occupied. A wasp confined with a dozen bees in a glass jar will for a long time dodge about among them without their being able to lay hold of him, while he is dealing bites, cuffs, and stings, if he has a chance, in the joints of a passing bee, and his black antennæ vibrating incessantly in every direction, showing intense nervous energy, and a mind fully alive to his peril, yet cool enough to enjoy its excitement too. I have seen a wasp pass along the inside of a glass hive among thousands of bees, clutched at by numbers, but doubling and twisting among them so adroitly that he ran the gauntlet the whole length of the hive, and got safe out again, no doubt somewhat glad, yet very little frightened on the whole. Hoping you will put in this scrap, I send it, knowing many others may have seen such curious sights of insect life, and may be induced also to send them.—C. Hope Robertson.

Marsden Rock.

THE ROCKS AND CAVES OF MARSDEN BAY.

WHEREABOUTS in Great Britain will you meet with the sternest realities, both in the outward aspects of Nature, and in the life of the people? In the far north, certainly; where hard rocks, and hard fare, and bleak winds, and a myriad minor difficulties effect a sort of compression of humanity, so that we have its essence in character, and intellect, and will. So I thought, after a northern tour which ended at the Tweed, in the midst of one of the bleakest winters of the last half century. But it was on the homeward journey, during which I halted for a week at Newcastle, that I had the best opportunity of forming an estimate of the reality of life northwards. Would you see men struggle against difficulties, with a perseverance and endurance such as has no parallel, on a general scale, in all the varied departments of industry? Then watch the Tyne boatmen where the river narrows at the old bridge, while the tide is at full flow and the stream covered with black craft. Would you make acquaintance with a scene destitute of every one of those natural graces of rural beauty which we are accustomed to regard as essentials of happiness? Then take a voyage down the Tyne, and count how many little black

bushes, representing shrubs killed by coal-dust, there are on the banks in the course of the first two miles. And if you want a sensation, wait for a fierce hurricane from the east in the month of January, when the wind, rushing in from the bleak German Ocean, tears over the bar, and up the Tyne valley, as if the end of the world had come, and the atmosphere was the element first doomed to destruction. Then do as I did; go on board a tug-boat and go out to sea boldly, and if the helmsman lashes himself to his post, and suffers the wind to scar his face into ribbons, as though the elements were transformed to whips of wire, and each whip wielded by a fury, imitate his example, and hold on to the end of your course, and be assured of one reality. My destination on the little tug, that pierced the wind like a well-shot arrow, was the Bay of Marsden, about five miles from Sunderland, where the magnesian limestone exhibits its boldest features and most decisive characteristics. Just now the same scene is as good a representation of fairyland as any in these islands. The wind has been westerly the greater part of the summer, and will probably continue so till near Christmas, and with the wind in any quarter but the north or east, commend me to the coast of Northumberland for the enjoyment of the picturesque and the pursuit of Recreative Science.

I'll tell you of a trip, easily accomplished, and full of wonders for a southerner. Take the night train from King's Cross for Newcastle. Lie full length in a first-class carriage, and sleep soundly till about three A.M., then bestir yourself and look out of the windows. You will then, or soon after, behold a landscape of indistinct hill and dale; on every hill a watch-fire, in every dale huge wreathing mists, as sublime in their indefinable magnitude as those that make a mystery of the sunrise on the Brocken. As you hurry on, the fires seem to break out in greater splendour, and they multiply, so that at last you appear to be inclosed within them, and those nearest your route are seen to be of vast dimensions, covering sometimes as much as an acre of ground. It is no gathering of the clans, no signal of revolution; you are simply nearing the coal-fields—have now begun to traverse them, and your journey ends in the very heart of the great depository of the carboniferous strata to which England owes much of its greatness among the nations. You may spend two days well in the inspection of the castle, the high-level bridge, the beautiful new town, and the quaint old town, which from the bridge appears to be utterly ruined and in process of interment, for it lies deep down in its grave, beside the hurrying waters of the busiest of tidal rivers. The market will show you Scotch cattle and Scotch shepherds, and the narrow streets near the waterside will present examples of human visages furrowed by toil and begrimed with coal-dust, each and all illustrative of the reality this side the northern border.

You know that Shields is almost wholly tunnelled under, for it is built over a most productive coal-mine, and beside the railway station the pit-fire blazes all night and all day like a permanent model of Vesuvius. Sunderland has its own peculiar points of interest, especially in regard to the class who go down to the sea in ships; and from either Shields or Sunderland the way to Marsden is as plain as roads and footways can make it. In my winter journey I landed at Tyne Bar, and took my way along the beach, deafened by the roar of the breakers. From Sunderland the journey may be in great part accomplished by rail, *via* Cleadon, or from South Shields, by way of Westoe, on foot. Having made the pilgrimage by each of the routes, I prefer that from Shields, by the footpath along the cliffs.

In whatever way the stranger approaches Marsden, he will soon be satisfied that he has alighted in a region as rich in interest, both for the mere sight-seer and the scientific explorer, as any on the coast of Britain. Its

very name is suggestive. It is the Mare's Den; the den or cave by the sea. To reach it from Tyne Bar, the walk lies along a grand beach strewn with boulders of honeycombed limestone, and bounded by a precipitous range of rugged cliffs on the right hand, and the "mysterious sea" on the left. If the temptation to gather tufts of *Laminaria*, and to remove *Actinia* and molluscs from their rocky anchorage, can be resisted, the journey can be completed in half an hour, and then there is Marsden Bay, with its grand semicircular expanse, full before him. But there are other temptations than those that spring out of the ordinary routine of marine studies. The cliffs are everywhere pierced with caves, grottoes, and landslips. At the first cliff after leaving Tyne Bar, you encounter some of the loveliest land-springs imaginable, the fresh waters from the upland working their way through beds of moss, which is so densely incrusted with fine sand as to be half petrified while in full growth. You trace these water-courses by the water-worn line of the stones and the fringes of moss that mark the channels of the rivulets till they are lost in the ooze and tangle, where the breakers seem to chafe more furiously because of the little empire the rivulets claim for themselves on the margin of the consuming sea. While conning the bold outlines of the cliffs, and noting the creamy, tawny, and ochreous hues that add to the boldness of the escarpments, you are charmed to hear, in the first bay, a tinkling sound, such as *might* arise from the pealing of a chime of fairy bells. It proceeds from the "Fairies' Home," one of the most curious of the water-worn caverns, which a guide will easily direct you to, and you may creep through a slippery archway into a dark hollow, and behold a fairy fountain of fresh water bubbling from the rocky wall, and flowing over the shining green floor into a series of depressions of the shape and size of large saucers, in which it spins round and round for ever, to the shrill music of its own bubbling, and the bass roar of the surf without. This spring is the "fairies' kettle," and the depressions are the "fairies' cups." You will imagine the cave to be formed of rough masses of copper-ore, but there is not a particle of metal in the limestone; the metallic lustre is wholly due to the cryptogamic vegetation and the imperfect illumination. Away from this spot the interest of the walk increases at every step, the cliffs are wilder, the sea birds wheel overhead more confidently, as if to say, "This is *our* home," and the tide-washed blocks appear to have been strewn about by a race of giants, bent on beguiling the surf to chase them beyond its proper confines. You are now reaching a district of caves and grottoes, and you pause at last to behold the broad expanse of Marsden Bay, with its broken outlines, and its strange admixture of the works of man with the works of Nature, and both in their most sportive moods as if in playful competition.

With but half a geological eye, you perceive that you are in a region of magnesian limestone, a portion of the great Permian formation, lying immediately over the coal. A careful scrutiny will further show that the strata lie unconformably, and a detailed examination will evince the fact that since its deposit it has been torn, and shaken, and shattered by upheavals and convulsions from below. The cliffs form the segment of a circle in their general outline, at the southern extremity of which there is a low range of rocks, forming a sort of detached breakwater, extending from beyond the southern end of the arc to about the centre, where it turns sharp round and bisects it by a cord running in to the land. At the northern extremity the cliff breaks down into a range of dark brecciated rocks, which run out to sea, and lose themselves in the water at the line of low tide. Within these two points the cliffs present a succession of vast broken surfaces, variously tinted with buff, ferruginous, and ochreous stains, and of varying

degrees of compactness, as evidenced in the irregularity of their submission to the denuding action of the sea, which has increased the wildness and grandeur of their outlines by its assaults upon the masses of greatest pulverence. In many places the bases of the cliffs are so water-worn that they appear to stand on a succession of honeycombed pillars, the interstices of which open into caves and hollows. From one of these there is a way of ascent, by means of a circular orifice, to the land above, originally formed, so it is said, for the convenience of smugglers.

All around within the crescent of the mighty sea-wall of natural cliffs, of from one hundred to a hundred and fifty feet high, are scattered masses of the same rock, evidently detached from the mainland by the wasting action of the sea. These are of closer texture than many of the cliffs that bound the scene, as the geologist will discover by testing them with his hammer; and to this, doubtless, they owe their preservation as isolated masses once forming integral portions of the limestone coast. "Pompey's Pillar" is one of these. It is almost an obelisk wholly formed of slabs of magnesian limestone, sculptured, honeycombed, and decorated with almost the regularity of an architectural work. In the very entertaining Guide-book, published by Ward, Newcastle, sold to visitors, there is another mass described as "on the east of the pillar, dislocated and broken, and still standing as if some invisible genie supported it in his cloudy arms." It was from this unnamed mass that I obtained the best specimens of one of the curiosities of Marsden, the flexible limestone. This can be detached in large laminæ of from nine to twelve inches in breadth, and about half the thickness of a common lead-pencil. Taking a sheet in both hands, and placing the two thumbs under it towards the centre, it can be bent to about fifty degrees of a circle. Pack up your specimens, and some time after attempt the feat again, and they crumble into fragments. The flexibility is dependent on the amount of moisture in the stone, and though very brittle when desiccated, they bend as easily as at first if plunged in water a few minutes previously. Another curious pillar is that known as Lot's Wife, a thin contorted shaft. Though closely related to the saliferous masses of the New Red, there is no saline matter in the rocks at Marsden; nevertheless, the pilgrim in Marsden Bay will be pretty sure to call to mind John Bunyan's description of the "old monument hard by the highway-side," at which Christian and Hopeful gazed so earnestly, and where, "after a little laying of letters together," they read out the inscription, "Remember Lot's wife." Close by is a grand mass of huge boulders running away in easy slopes to the sea, all covered with masses of emerald green vegetation, and appropriately named the "Velvet Beds." Those who can traverse these slippery surfaces will discover in them the proofs that the marine flora of Marsden is not to be contemned, for, besides the broad glistening meadows of Ulva, Enteromorpha, Laminaria, and Cladophora, there are also some more interesting forms of rarer kinds, such as Bryopsis plumosa, Chondrus crispus, Ahnfeldtia plicata, Cystoclonium purpurascens, Dumontia filiformis, with Corallines and Janias, and amongst them, all the commoner zoophytes, crustaceans, and mollusks of the east coast; but I never met with any rare animals even during a summer exploration.

We approach, at last, to the two "lions" of the place. Looking seawards we descry the huge rock of Marsden, to which all the pillars and detached cliffs are subordinate. This is a table-rock, isolated, and remaining uncovered at the highest tides. It stands all alone in its glory, like a bulwark or tower of defence to the *other* "lion," which lies snug under the cliffs, or rather hides itself within the cliffs, the caverned hostelry of the once famous Peter Allan. These are the

principal objects of attraction to holiday folk from the adjacent towns of Sunderland, Shields, and Newcastle; where they waken the echoes, in the summer-time, with their merriment, and frighten the sea-monsters with the sounds of fiddle and bugle, and the laughter that mingles with the rustic dance within the recesses excavated by the genii of the place, Jack the Blaster and his successor Peter Allan. Marsden Rock rises 109 to 130 feet in height, is about 230 feet in length, and 120 feet in breadth, and the surface comprises nearly an acre of ground. It is easily accessible by means of ladders and the excavations from the side, through to the top, accomplished by Peter Allan, who played Robinson Crusoe on it, and after exterminating the wild-fowl with his unerring gun, peopled the rock with white rabbits.

This is of the same magnesian limestone as the cliffs, the whole of the laminæ of which are shattered into small, angular pieces; but all retain their original places of superposition. The base of the rock is worn into pillars, so that at low tide it appears in many places like an ancient and ruined architectural structure. The pillars are eaten away into fissures and perforations, and the sea dashes in and out between them with an impetuosity that threatens some day to bring down the whole. But the mass is firm enough to endure for centuries, as may be seen by an examination of the base through the natural archway, which affords a glimpse through it of the shipping in the offing. From the summit of this rock a fine view of the whole of the bay may be enjoyed, for the enjoyment of the picturesque alone, or for combining with it a geological survey.

These magnesian limestone rocks lie immediately over the coal measures, and belong to the group formerly designated New Red Sandstone, but now classed in the great section of the Permian, so named by Sir Roderick Murchison, to harmonize with his Silurian, Devonian, etc., this group being extensively developed in the Russian government of Perm. The strata next above these are those of the Mesozoic, or Triassic group, which consist chiefly of coloured marls, beds of rock-salt, and variegated sandstones, exemplified in the sandstones of Cheshire and the saline beds of Worcester; the lowest of the group, which lie immediately over the Palæozoic, or Permian, being well exemplified in the magnesian limestones of York and Durham.

The large per centage of carbonate of magnesia in the rocks at Marsden,* and their susceptibility to erosion by water, are the points of their history that first arrest the attention of a geological pilgrim. There is no group of rocks on any part of the coast more picturesquely water-worn, honeycombed, and internally fractured than these. Many of the largest cliffs are made up of fragmentary masses, or very regularly brecciated throughout their whole structure. In exploring the face of a cliff, or one of those natural obelisks that adorn the bay, it will be easy to detect occasional layers of powdery material, alternating with concretionary masses, the concretions frequently resembling bunches of grapes. These variations of texture explain the readiness of these rocks to yield to aqueous friction, and the thousands of arches, tunnels, caves, pillars, and abutments, which characterize the bases of the great masses, indicate how the softer portions of the rock have been removed by the devouring sea, and the harder materials left for the support of the superincumbent masses. It seems, indeed, as if after the deposit of these beds *in situ*, and their complete consolidation, they were broken up by internal convulsions and again reconsolidated by the transfusion of calcareous cements. Such a conclusion will force itself upon the mind of any thoughtful observer who will compare the oblique laminations of Pompey's Pillar with the horizontal angular layers of Marsden Rock, all testifying to shocks from within

acting without uniformity on the polarity of the strata.

So much for the general physical aspects of these remarkable structures. In their palæontology the observer will soon discover that their fossils increase in a descending order. Towards their summits they are barren almost beyond hope; at their bases they are pretty sure to reward a diligent search. To indicate, much less describe, the palæontological features of these rocks would demand too much space in this general sketch; suffice it, that the Permian formation is adequately represented, and the practical geologist is reminded of a fruitful quarry.

Reference has been made to the excavations of a strictly artificial kind, and these are, in truth, the great attractions to holiday folk who visit Marsden Bay. The great rock of Marsden plays the part of bulwark to a hermitage under the cliffs, where the renowned Peter Allan plied his skill as a miner in excavating a series of chambers in the face of the cliff, in the front of which he constructed a hostelry, and gathered together an extraordinary number of curiosities. Whatever were the motives of this local Crusoe, he certainly accomplished some extraordinary works. There are fifteen rooms hewn out of the solid rock, and they are respectively known as the "dining-room," the "devil's chamber," the "jail-room," the "ball-room," etc., etc. The last-named is perhaps the most curious of any. It is a large cave supported by pillars, with a planked floor, and numerous dark recesses, one of which is much used as a place of romantic retreat for young lovers who have already exchanged glances to the music of a fiddle in the ball-room.

When the cave and its recesses have been explored, there remains for the pilgrim in search of the picturesque, the history of the famous Peter, which may be pleasantly conned on the spot by the help of the Guide-book just referred to, and to which innumerable additions will be made by Peter's family and friends at the cavern, where good English cheer may be enjoyed in remote seclusion from the world, within the hearing of the

Ball-Room.

angry surf, and with the finest of sea-views spread out before the pilgrim as a moving panorama. Peter held possession of his rock-hewn tenement two and twenty years, and his grave may be seen in Whitburn churchyard hard by, where a simple stone bears the inscription (so chosen because of his name and occupation)—

"THE LORD IS MY ROCK AND MY SALVATION."

If any reader, who through this brief notice of a remarkable district, should hurry away to Marsden Bay, and enjoy only a hundredth part of the pleasure I have experienced there, there will be no occasion for regrets. It is a place equally adapted to delight the tourist in search of health and amusement, the gatherer of things curious in human biography, the serious savant bent on quarry-

ing the depths and dips and physical constitution of the ancient ribs of the earth; or the aquarian amateur, who with eager eyes looks upon the sea-shore as a fishing-ground, and mingles with his reminiscences of marine scenery the details of his captures by dredge and hand-net. There is nothing small or mean about the Bay of Marsden; Nature shows herself there in grand proportions, as the mistress of the marvellous, and the sphynx who propounds great riddles.

SHIRLEY HIBBERD.

PREVALENT THEORIES OF SPONTANEOUS GENERATION.

WHY is it that the contemplative and thoughtful mind is so deeply interested in the great scientific question of the day, the "origin of species"? Why is it that we find some of the master intellects of the age give in their adherence even to the plausibility of the hypothesis by which Mr. Darwin attempts to elucidate this question?

Both these questions may be answered in a few words. We live in an age of SCEPTICISM. The human intellect has burst through the bonds of rational induction, and is running wild in the hopeless mazes of assumption and conjecture. Thus the grand induction of the special creation of organized beings has been given up by Darwin and Hooker, by Huxley and Grant, and Dr. Asa Gray, and the doctrine of the genetic origin of all living things in one primordial organism has been substituted in its place.

The last finishing touch to this new doctrine has been given by Dr. Grant, who, in a recent publication, entitled a "Tabular View of the Primary Divisions of the Animal Kingdom" (Walton and Maberly, 1861), has not only recorded his adherence to Mr. Darwin's hypothesis, but has gone far beyond it. Mr. Darwin inferred that all organic things were derived from one primitively *created* form. Dr. Grant tell us the "forces of gravitation, cohesion, and affinity of the *mineral kingdom* are converted in the vegetable kingdom into complex chemical forces, effecting higher organic combinations, producing new and remarkable properties in the compounds, and *eliciting vital phenomena* believed by some (*sic!*) to belong to a class distinct from those of chemistry and physics. This highly-prepared organized matter forms the food of the animal kingdom, where the *accumulated, concentrated*, and *converted* forces effect combinations, *produce* properties, and *elicit* phenomena of a more transcendant character, *constituting the life of the higher organizations*."—(P. 91.)

The general reader will not be surprised to hear that a book containing doctrines like these should be dedicated in glowing words to Mr. Darwin. "With one fell swoop of the wand of truth," says Dr. Grant in the dedication, "you have now scattered to the wind the pestilential vapours accumulated by 'species-mongers' over every step of this ever-varying, ever-charming part of Nature's works; and your next movement will dispel the remaining clouds of 'mystical supernatural typical intrusions,' which still hang on the horizon of the sublime prospect now opening to the view *of the natural animalization of the orbs of space by the same simple laws which govern the physical and chemical phenomena with such wondrous harmony throughout the rest of the material universe.*" —(Dedication, p. vi.)

I ventured, in a work* published last year, to bring forward proof that Mr. Darwin's hypothesis, if true, must destroy the

* "Species not Transmutable." Groombridge.

foundations of the religion of the Bible. I went further; at page 76 I remarked:—"The author of the 'Vestiges' believed in spontaneous generation. Apply this belief to the formation of Mr. Darwin's original organization, and the whole face of living Nature may be swept away from the evidence of religion, and we should have to fall back upon the 'countless spheres' where fortunately 'natural selection' can never reach."

I certainly did not think, when I penned those lines, that we should have, within eight or nine months, the announcement gravely made, by a distinguished comparative anatomist and a professor in one of our colleges, that "spontaneous generation" was not only a great truth, but that it was not even an exception, but the rule of the formation of animal forms.

"Thus all animals and parts of animals originating *de novo* from their fluid elements, and passing through the conditions of liquor, plasma, nucleus, and cell, the dogma of Harvey, *omne vivum ex ovo*, suitable to the evolution period, is now changed, by the microscopical investigations both in the vegetable and animal kingdom, to *nullum vivum ex ovo*."—(Grant, "Op. Cit.," p. 86.)

Again, at page 81, in describing "infusorial animalcules," he says, "always distinctly originating *de novo* from their fluid elements." Further, the monad is thus described:—"Appearing at first as particles of albumen or gelatine, formed from their fluid organic elements in the infusions of vegetable or animal matter in the waters of the globe; never originating *ab ovo*, nor by the metamorphosis of pre-existing vegetable cells, but readily multiplying by fissiparous generation, and metamorphosing into an indefinite series of higher forms, as do also the protophytic germs of plants."—("Op. Cit.," p. 87.)

Dr. Grant, then, not only endorses all Mr. Darwin's views—not only takes them in their totality as proved facts, but he fills up the little left in the measure by asserting the doctrine of spontaneous or equivocal generation as established.

Now, in the mere fact of the animalization of vegetable matter by its own inherent forces, I can see no special objection if it can be proved to be true. It may be merely an act of creative power rendered visible, and the secondary cause, viz., the inherent force in the vegetable infusion, may be one of the means used by creative wisdom whereby creation is effected.

What I object to is, first, that the spontaneous generation is assumed to be true, and then that a long series of developmental changes are assumed to follow, by which species are formed, and the world filled with animal life.

"No animal can be formed by Nature or Art in its perfect state *de novo*, or even *ab ovo*, without its passing through the entire long series of developmental changes peculiar to each."—("Op. Cit.," p. 89.)

It has been urged against my former work that I mixed up religious feeling with scientific matter, and it has been most unjustly said that I have endeavoured in that book to raise or revive the *odium theologicum*. The same weak-minded people may lay against me a similar argument now, because I have stated, and again repeat, that the theory of the development of species as argued by Mr. Darwin, and as further attempted to be carried out by Dr. Grant, has not been proved to have a basis of truth; that, in fact, both hypotheses are, according I believe to the very best and most trustworthy inquirers of modern scientific men, with all their improved means of investigation, proved to be untrue.

I should never have alluded to the religious part of the question had I not considered that the views held by Mr. Darwin were opposed directly to revelation. If I had brought scientific evidence from the Bible to oppose the scientific deductions of Mr. Darwin, I should have rendered my-

self open to the charge of raising the *odium theologicum.* But I did no such thing. I stated, as the grounds for my opposition, that Mr. Darwin's views were formed on assumption, that they were not susceptible of proof, and that I did not consider he had attained a *locus standi,* from which he could open a successful battery against that doctrine of creation which was consistent with revelation. As one who had devoted the best part of his life to scientific pursuits, I felt tired of that continued effort to reconcile revelation with science, which generally ended in a kind of compromise, in which the former was sure to suffer. There is surely nothing unfair, entertaining as I do these opinions, in doing battle with Mr. Darwin. But another aspect has been put on the controversy since the publication of my book.

Dr. Asa Gray, in a very well-written and well-argued pamphlet in favour of the Darwinian hypothesis, has endeavoured to prove that it contains nothing which is opposed to revelation. Now, this is a position no one of mark has ventured to take in this country, and I can very readily imagine that in a country where the Negro is considered by many as a lower species than man, that the distinct, and clear, and unequivocal account of the creation which is contained in the Mosaic history should be superseded by a human hypothesis, which refers the creation of man and all living things to secondary causes, acting fortuitously for past ages, before the period referred to by the inspired writer. But in this country the great mass of people are believers in the truth of the Bible. Our religion is entirely founded upon the Mosaic account of creation. If man was not, as there stated, specially created, there could not, by any possibility, any stretching of imagination, be a period allotted to him in which the first great sin was committed, which rendered the appearance of a Mediator necessary, and without a Saviour the whole Christian religion must fall to pieces.

Now mark: this, I say, is the ground upon which I have come forward to oppose Mr. Darwin. I do not use this as an argument against his scientific inductions, but simply as a reason why I should prove, if possible, that those inductions are unsound. Surely, then, as the "Athenæum" remarked, we "are manly and well met."

I may here notice another argument which reviewers have used. A comparison has been made between Mr. Darwin as a great naturalist and myself as one, comparatively speaking, not known, and I have been accused of presumption in daring to find fault with such a man. There is a great deal of very erroneous and mischievous feeling in such a remark. Mr. Darwin has written a very able work upon the fossil and recent Balanidæ. If I had written a work to disprove any of the facts in that book, without a thorough knowledge of the individual anatomy or specific characters of those molluscs, I should have been open to such a charge. But Mr. Darwin's theory of the "Origin of Species" is founded, in a great measure, upon the facts of others, and Grant's hypothesis of "Spontaneous Generation" entirely so. The two questions refer to zoology and comparative anatomy, and physiology and histology, as they are related to us in books. I am, therefore, as competent to generalize upon known facts as either of them, and I trust we shall hear no more of these pedantic criticisms.

Of all the points connected with Mr. Darwin's theory, the physiological part of the question has received the least attention. This is partly because it is dead against him, and partly because a great many reviewers—even those who venture to make comparisons about men's fame—are entirely ignorant upon the subject. It is, however, in physiology that the great argument against Darwin is to be found. It is all very well to say that the cauliflower and turnip, being descended from two species of cabbage, you obtain in

these two species a *locus standi*, whereupon you may infer that they were therefore descended from the same parent. And a great deal may be analogically founded on such an argument. But until it is proved physiologically that the vegetable matter of the cabbage is the transmuted result of forces acting upon matter which was the common origin not only of cabbages and all vegetables, but of animal matter also, the whole theory of Darwin falls to the ground.

Dr. Grant says that such is the result, but he does not accompany the statement with any kind of proof or attempted proof. He says, *nullum vivum ex ovo*, and that vegetable matter has the power within itself of animalizing the world! In other words, he believes in the spontaneous or equivocal generation of animal life.

Now, if there is one question which has more than another received the earnest and most zealous attention of naturalists during the last fifty years, it is this. And what are the results?

The world was startled so late as last year (1860) by the experiments of M. Pouchet. Since the memorable failure of Crosse and Weekes, no experiments have obtained more attention than those of Pouchet. After apparently most careful and elaborate efforts to examine the atmospheric air in all places, and bringing its contents to the test of microscopical investigation, he announced to the scientific world that it did not contain the ova of animalcules which are supposed to become developed in vegetable infusions! Here was a grand discovery! Equivocal generation was *proved* at last, and the development school was in ecstasies.

Alas! the ink was hardly dry upon Pouchet's statement, when another experimentalist, of equal credibility, utterly destroyed it. Nay, more, M. Pasteur has proved, if well-conducted experiments by an able man are of any value, that not only is Pouchet's account wrong, but the *converse is true*. His statement is so important as bearing upon this subject, that I will insert here a *resume* of it from M. Pasteur's valuable paper in the "Comptes Rendus," Sept. 3, 1860, p. 348.

M. Pasteur introduced into several glass flasks, measuring 250 cubic centimetres (about 100 inches English), a quantity of albuminous water from the yeast of beer, and albuminous water containing sugar, etc., so as to fill one-third of the vessel. He then drew out the necks of the flasks in the spirit-lamp, and the liquid was made to boil. During ebullition the slender extremity of the flasks was closed, and a vacuum was produced in the flask. In a given locality he then broke off the closed ends and allowed the air to rush in, which it did with considerable force, carrying with it all the particles of dirt or other matter suspended in it. The flask was then immediately closed in the blowpipe, and placed in a stove heated to 20° or 30° centigrade = about 42° to 62° Fah., that is to say in the best condition for the development of animalcules and mucores.

In most cases the liquid decomposed in a few days, and organisms of the most varied kind appeared in the flasks; far more varied, in fact, especially as regards mucedineæ or torulaceæ than would have been produced if the liquids had been exposed to the common air. But, on the other hand, it often happened, several times in each of the experiments, that the liquid remained absolutely unaffected, whatever might be the duration of its exposure in the stove! As much so, in fact, as though the air had been exposed to a red heat. Thus M. Pasteur remarks, "the atmosphere is far from constantly capable of affording the cause of the so-called spontaneous generation. And it is always possible to procure in a given locality, and at a given moment, a considerable balance of common air which has undergone no sort of physical or chemical change, and which is, nevertheless, wholly incapable of giving rise to infusoria or mucedineæ in a liquid which

undergoes decomposition very rapidly, and invariably when in free contact with the atmosphere."

"*Nothing*," he continues, "*is more easy than to augment or diminish either the number of flasks in which organisms are produced, or the number of flasks in which they will be totally absent.*"

M. Pasteur then relates some most interesting experiments which he made in the vault of Paris Observatory. Here the annual temperature is equal, and the perfectly calm air would evidently allow every particle of dust to fall to the ground in the intervals of disdisturbance which might be caused by the movement of the observer or his objects. Consequently, all precautions being observed when the flasks are taken in, those which will ultimately afford no organisms ought to be considerably greater than when filled from the court of the observatory. *And this is exactly what does take take place.* The air in the vaults, when taken out with precaution, so as to avoid disturbance, proved as inactive as that *which had been heated to the temperature of red hot iron.* And this result was not the consequence of any special inactivity; on the contrary, when saturated with moisture, as the lower organisms do not require light for their existence, this air always appeared to the author more fitted for the development of organisms than that on the surface of the ground.

In conclusion, M. Pasteur arrives at the fact that the ordinary atmospheric air, only here and there and without any constancy, presents the conditions necessary for the so-called spontaneous generation.

Germs exist in one situation—close by, none at all—at a greater distance, some of a different kind. They are abundant or the reverse, according to the locality. Rain lessens their number. In summer, after a succession of fine days, they abound; and in places where the atmosphere has been perfectly calm for a long time, the germs are entirely absent.

M. Pasteur asks why Gay Lussac's celebrated experiment with heated or artificial air succeeded, or why Pouchet's experiment with the mercurial bath was always successful?

The answer to these questions is very remarkable. Gay Lussac and Pouchet thought that if organisms appeared in air which had been heated over mercury, the fact was conclusive as to the absence, at all events, of germs.

But M. Pasteur observes that the mercury itself is full of germs. He took a small globule of mercury, about the size of a pea, from an ordinary bath, and placed it in the decomposing liquid in an atmosphere previously heated to redness; and in every experiment in two days organisms of various kinds were produced. But if the same experiment were made with a portion of the same quicksilver which had been *previously heated*, not a single living organism was produced.

Now, are these experiments to be relied upon? I will not insult a distinguished foreign *savant* by requesting an answer to such a question. It is the weakest of all weapons, is that disbelief which is sometimes used instead of argument, springing either from peculiarity of mind, or much more frequently from ignorance. If we are to disbelieve experiments like these, there is an end altogether of scientific confidence.

In the face, then, of these experiments, what becomes of Dr. Grant's dogma that the monad never originates *ab ovo?* or that animals "always originate from the chemical union of fluid elements, never by evolution from indefinite ancestry"? I ask here, as I did in my strictures upon Mr. Darwin's work, if it is a fair or just mode of reasoning out questions of such momentous import as these, upon data which are not only not proved, but are positively disproved?

But it is essential to Mr. Darwin's theory that he should have a force like that which can

animalize vegetable matter, and which is further endowed with an inherent and inalienable power of transmutation into higher structures. This power he calls variation, so that it is intimately connected with the doctrine just propounded by Grant.

Dr. Grant's theory is simply this: he says that the nucleus of the first formative animal cell originates *de novo* from its fluid organic elements, either in the infusions of organic matter in the *exterior* waters of the globe (*monadinea*), or in the interior of bodies already organized (*endocystica*), never by evolution from indefinite ancestry.

This is Dr. Grant's idea of creation by secondary laws; but it is completely upset by Pasteur's experiments, which I have related above, at least that part of it which refers to the monadinea in vegetable infusions. The other means of animalization by endocystics, or the elementary or primitive molecules, granules, or cells of organic structure, Grant has classed among the animals of creation under the quaint and provisional arrangement of genera—*octeocystion* (originating bone), *myocystion* (originating muscle), *chondrocystion* (originating cartilage), *neurocystion* (originating nerve), etc.

The above genera are under the first suborder, *histocystica;* he then makes a second sub-order, *hygrocystica,* under which he classifies the provisional genera, *hemacystion* (blood corpuscle), *myxocystion* (mucous corpuscle), *galacystion* (milk corpuscle), etc.

That these are living organisms, no histologist of modern days will deny; that they are independent members of the animal creation, I think very few will be inclined to admit. One of the most celebrated of modern histologists has written a large book upon the ultimate structure of animal structures, in which he has, with singular ability, urged the origin of all such structures in cellular tissue. Instead of the dogmas *omne vivum ex ovo* of Harvey, or the *nullum vivum ex ovo* of Grant, Professor Virchow has endeavoured to establish that of *omne cellula e cellula.* Now, surely if Pasteur has demolished the doctrine or hypothesis of spontaneous generation, or the animalization of vegetable elementary matter; in other words, if Pasteur has destroyed Grant's doctrine of the formation of *monadinea,* and Virchow and other eminent histologists have destroyed his theory of *endocystics,* what becomes of his support to the Darwinian hypothesis of the origin of species? Why, it is simply placed in the same position as the great majority of Darwin's arguments, on the platform of pure assumption.

I will now turn my attention, for a short time, to the pamphlet of Dr. Asa Gray, and also to his criticism of my work, "Species not Transmutable," in "Silliman's Journal." I wish to give every credit both to the pamphlet and its author. I never denied the high position and the great merit of Darwin as a naturalist. Grant has a European fame, and Dr. Asa Gray is one of the most distinguished men in the new world, and well worthy to be ranked with Agassiz in the highest niche of science.

I think, however, in his attempt to reconcile Darwin's views with Revelation, he has signally failed. His exposition is eloquent, ingenious, singularly clear and argumentative; but, notwithstanding this, I think I can prove that his argument has broken down.

I am perfectly unprejudiced in this matter. As one of the great body of human beings, I believe there is attached to them a responsibility both of things moral and divine. Like the rest of the Christian world, I derive this knowledge *only* from the Bible. Natural religion shows me clearly enough that there is a God; its beauties fill me with delight; its complexity and its harmony, with wonder and astonishment. But of my responsibility as a denizen of that beautiful world of Nature, I can only derive a knowledge from the Bible. Without that intimate knowledge of dead languages which would give me

a scholar's right to criticize the statements of the Bible, I am content to trust to the honour and integrity of those high classical authorities who tell me that those statements are correct. The great mass of mankind can say no more. Until these authorities are disproved by greater, I must believe them; and until science has upset the statements of the Bible, I must take the liberty of believing in both. If they come into collision, I must believe that is right which my clear unbiassed understanding tells me is so. If the Bible told me that I had three hands, I should unhesitatingly disbelieve the statement; but if it told me that I had a body wonderfully and fearfully made, and especially created by the fiat of the Almighty Power, I should unhesitatingly believe this, instead of a mere unsupported hypothesis, that I was formed by variation from animals lower than myself in the seale, and by the same secondary causes which we see exercised in the production of rain or sunshine.

Dr. Asa Gray says he can have no confidence in one who reasons thus, forgetting that such an analogy has nothing to support it. Secondary causes produce sunshine and rain, but a great First Cause made the sun and the water. So I believe that while *secondary causes* are the means by which my body grows and lives, yet was the first human body specially created by the same First Cause. Dr. Asa Gray says that he can readily believe in the influence of design being brought about by secondary causes as by special creation, and Darwin introduces a "divine" into his book, who says the same thing. But they neither of them touch the real question. Nobody pretends to argue against secondary causes, unless the belief in them is applied in opposition to the belief in a First Cause. Both exist independently of each other, but they are inconvertible terms.

God made man, and when He did so He endowed him with the power of living, and growing, and increasing by secondary causes. Darwin says, and his supporters agree with him, that man and all other animals were formed during the operation of secondary laws through myriads of years. Here I join issue, and I say, your hypothesis is not only improbable, but the facts by which you support it are overstrained or not real, that your deductions are drawn from false data, and that your results are totally opposed by the direct and uncontroverted testimony of Scripture.

Surely, then, the argument here is plainly enough stated. If I am wrong, the proof of my error is very easily produced. We do not want long, elaborate, highly-wrought, though often obscure, reviews or articles to prove that I have raised the *odium theologicum*, or that I am out of court because I have allowed my feelings to express the indignation I felt when such a momentous subject as this has been attempted to be proved upon mere assumption. Instead of all this, I demand that you should show me physiologically that the inherent structure of animal organisms has within it a force, operating by variation, which shall produce different species, genera, orders, and classes. I demand that you shall prove to me that the various animals of creation have existed at times, either geological or recent, in a condition, as regards form, structure, and habits, intermediate between the descendant and its presumed ancestor; and then I have a right further to call upon you to prove that the design which we see in adaptation of species to the circumstances of its existence, has also been a visible and intelligible attribute of the creature throughout the various phases of its varying existence.

If these conditions are not complied with, I must unhesitatingly claim for the old doctrine a preference over the new. It is not enough to say that both are hypotheses, and neither susceptible of proof. Such a mode of reasoning would be a surrender on my part of the clear and, as I think, unanswer-

able arguments in favour of special creation—it would be covering the weakness of my opponent's case with the strength of my own.

Should the subject be thought sufficiently interesting, I will further consider the arguments in Dr. Asa Gray's able pamphlet in a future paper.

C. R. Bree, M.D., F.L.S.

Colchester.

ON CERTAIN HABITS OF THE HORNBILLS.

The hornbills (*Buceridæ*) constitute a group of birds of large size, with ample wings and tail, remarkable for the excessive development, in the adult, of the beak, and the singularity of the huge hollow casque which surmounts the upper mandible. This casque varies in shape in the different species, but in all it has a strange and even grotesque aspect, adding greatly to the magnitude of the beak, which without it is sufficiently large, so to speak, being at the same time very robust, pointed, curved with a sweep downwards, and forming a very efficient weapon either for offensive or defensive operations. The nostrils are little holes at the upper part of the base of the upper mandible, adjacent to what we may call the forehead, just above the osseous rim of the eye. The eye is large, and both eyelids are furnished with lashes, but those on the margin of the upper eyelid are very long and strong, forming an elegantly-arranged row of wiry elastic bristles, more than covering the naked space below the eye when the lid is closed. This naked space surrounds the eye, but is more conspicuous below the eye than above. The angle of the lower jaw is continued far backwards, and is peculiarly strong, the intermediate space between each being considerable, so as to leave abundance of room for a dilatable gullet, to say nothing of the larynx. The feathers covering the ears, and those on the top and back of the head have lax dishevelled vanes, and appear of a silky or woolly texture with fine bristle-like shafts.

In young birds, the edges of the two mandibles are in tolerably close and even contact, but in adult specimens each mandible has its edge, as if by hard usage, so notched and jagged (and that the more so and the more irregularly as the bird becomes older), that the edges do not fairly meet except towards and at the apex. There is a disposition (we speak from our own experience and from specimens before us) in the horny sheathing of the mandibular bones to peel, like the bark of the plane-tree, new layers being added as the exterior are thrown off; and what makes this the more likely is that the difference in the magnitude and development of the beak, between the young and the adult bird, is astonishing. We do not positively assert this exuviation to be a fact, but we strongly suspect it, seeing that in numerous specimens which have come under our examination, layer after layer peels off, fresh layers, more and more delicate, being in preparation beneath. In the toucan (*Ramphastos*) nothing of this kind is observable; the beak of this bird might be carved out of the finest grained horn, so light is it, so firm, so glazed, so neat and elastic. Heavy and solid indeed is the beak of the hornbill, but how different in its coarse texture from that of *Ramphastos*, yet in both instances this organ is remarkable for its amplitude.

We have said that there is a vast difference in the magnitude and development of the beak, and its casque-like appendages, between the young and the adult hornbill,

but we have no data upon which to declare the ratio of its increase in any one given species. In fact, we have yet much to learn respecting this group of birds. But we see that there is no casque, or but a very slight indication of it in the young; nevertheless, even in young birds, the base of the upper mandible being very deep, we find the upper portion above the palate, almost to the tip, occupied by a most beautiful cancellated or cellular structure, a maze of cells irregularly divided from each other by the most delicate bony partitions, or laminæ. In the adult birds the vast casque, whether upturned like a horn, or spreading, with a drum-like roof and anterior angles, is interiorly a maze of cells, lined with a most delicate membrane, over which ramifies the fibrils, inconceivably minute, of the olfactory nerves.

As in the toucan, where a similarity of structure presents itself, the sense of smell must be acute. We owe the demonstration of the olfactory nerves in the toucan to Professor Owen, now of the British Museum, whose unremitting labours in anatomy, palæontology and physiology have conferred upon him merited fame.

The cancellous structure, however, in the casque of the adult, of one species at least, viz., the Rhinoceros Hornbill, is not continued beyond the base, for the terminal half is quite hollow. In the upper mandible this cellularity is beautifully developed; nor is it altogether wanting in the lower manible, although not very conspicuous. Hence it is that enormous as the beak may be, its weight is not proportionate to its magnitude; though, after all, it is by no means a light and flimsy apparatus. Moreover, it is worth remarking, that while this cellularity of structure tends to the diminution of weight it maintains the strength of the horny sheathing, even better than if it were interiorly a solid mass.

We have said that we have some reason to believe that in young birds, if not in adults, the exterior horn of the beak peels like the bark of the plane-tree, fresh layers being produced as the outer fall off; and we find that the Europeans resident in the Moluccas think that the marginal notches and irregularities of this organ are the mere result of age, and are yearly added to by fresh layers of horn. This exuviation is probably confined to birds which have not yet attained their fully mature stage of existence.

The hornbills are essentially arboreal, and indeed, as a general rule, are very rarely to be seen on the ground. The base of the toes forms a grasping palm; of these the outer and middle are united as far as the third joint. The hind toe is strong, and well opposes the three anterior toes, while the tarsi are short and stout. Greatly was Major-General Hardwick in error when he considered the palm-like toes of these birds as fitting them rather for the ground than the trees; but he was deceived by the palm, and forgot, or overlooked, the shortness of the tarsus, and the opposable power of the hind toe. The chimpanzee and gorilla have palm-feet, but they are not for this the more habitually terrestrial; besides, had the General considered the beak, the wings, and the spread of the tail-feathers, he would not have expressed his surprise at their arboreal habits.

Other writers have fallen into other errors. Lesson, for example, states that the hornbills of Africa feed on carrion, while those of the East Indies are frugivorous, seeking for aromatic fruits, and especially nutmegs, when their flesh acquires a delicious flavour. Now both in Africa, India, and its islands, they are omnivorous; and, indeed, the concave hornbill of India, Java, and the other islands, dissected by Professor Owen, was observed to prefer animal to vegetable matters—that is, such as in this country could be offered it. A dead mouse, for instance, would at once induce it to quit its vegetable diet, and this little bit of carrion—this "small deer," as mad Tom says —it would munch and squeeze between its mandibles, and then, the relish being gained,

swallow entire. The toucan acts in the same way, as we can testify from personal observation. The hornbill, whether African or Indian, is, in short, omnivorous; fruit, eggs, nestling birds, reptiles, perhaps even carrion (properly speaking) constituting its diet.

Among the trees of the forest this large bird is alert and active; it leaps with ease from branch to branch, and flies along the glades with an easy sweep, but each species has its own wing-flapping action.

With respect to the voice of these birds, with a *sounding board* above their great cellular bills, something extraordinary may be expected. Some have compared it to a sonorous roaring. Lesson says it is terrific, resembling flaws of rough and sudden winds (*grains de vent brusques et subits*), such as often arise in the eastern intertropics. Some compare it to a loud braying roar, sounding to the distance of half a mile. All this is exaggeration. No doubt the voice is loud, but the voices of other birds are as loud and far more startling and appalling—that of the great Virginian eagle owl, for instance, and of some of the *Caprimulgidæ*.

The hornbill incubates in the hollows of time-worn trees. There is nothing remarkable in this, as many birds—the woodpeckers, for example—do the same; but we never heard of any other birds the female of which is imprisoned by the male during incubation, as is the female hornbill. We have reason to believe that in most of the species, probably in all, the female is similarly treated. At all events, it is the case with a species found in Ceylon, another in Java, and another in Africa. This blocking-up process is conducted in the following manner:—When the female has laid her eggs, and fairly begins her task of incubation, the watchful male closes up the entrance of her chamber with a plaster wall of mud or clay, intermixed, as it would seem, with small sticks and stones, leaving only a narrow aperture, which her great and formidable beak closely fits, acting at once as a barrier, and a defensive weapon. Thus immured she is assiduously waited upon by her mate, who carefully supplies her with food, while she successfully guards her eggs and nestlings from marauding monkeys and the larger snakes. Such is the substance of the account given by Sir James Emerson Tennent ("History of Ceylon") respecting the double-casqued hornbill (*Buceros pica*, Scop., *coronata*, Bodd.).

Sir J. E. Tennent states that this hornbill, with its enormous double casque, frequents the lofty branches of the tallest trees, where it sits to watch the motions of the reptiles and smaller birds on which it preys, tossing them into the air when seized, and catching them in its gigantic mandibles as they fall (in the same manner as does the toucan). He then adds that this hornbill is also frugivorous, the natives asserting that when "endeavouring to detach a fruit, if the stem is too tough to be severed by his mandibles, he flings himself off the branch, so as to add the weight of his body to the pressure of his beak. The hornbill abounds in Cuttock, and bears there the name *Kuchilla-kai*, or Cuchilla-eater, from its partiality (wonderful to state!) for the fruit of the *Strychnos nux vomica!* The natives regard its flesh as a sovereign specific for rheumatic affections." See also "Asiatic Researches," ch. xv. p. 184. *Query*, May not the impregnation of the flesh of the bird by strychnine (probably only in a very slight degree) render it really medicinal, as the native Cingalese assert it to be? We ought not lightly to reject all testimony on such a point, though the testimony be that of superstitious natives. We may here refer to a paper on this species by Edgar L. Layard, Esq., in "Mag. Nat. Hist.," March, 1853.*

In a Javanese species of hornbill, to which we have already alluded, the same general

* See "Ann. and Mag. Nat. Hist." vol. xi., Second Series, for an account of the habits of *Buceros pica*, and *B. Cingalensis*, p. 234.

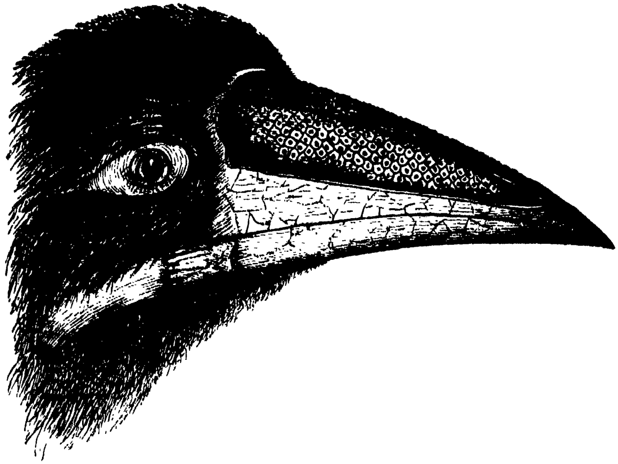
habits and the same mode of blocking-up the female during her term of incubation, present themselves, as was observed by the late Dr. Horsfield, whose scientific labours in that island, together with those of the lamented Sir Stamford Raffles, need no comment.

The following full and interesting account of the korwé, or red-billed species of Africa, is given by Dr. Livingstone, in his "Travels:" "We passed through large tracts of *mopané country* (a district abounding in the mopané tree), and my men caught a great many of the birds (hornbills) called korwé (*Tockus erythrorhynchus**) in their breeding-places, which are holes in the mopané trees. On the 19th of February we passed the nest of a korwé, just ready for the female to enter. The orifice was plastered on both sides, but a space was left of a heart shape, and exactly the size of the bird's body. The hole in the tree was in every case found to be prolonged some distance upwards above the opening, and thither the korwé always fled to escape being caught. In another nest we found that one white egg, very much like that of a pigeon, was laid, and the bird dropped another when captured. She had four besides in the ovarium. The first time I saw this bird was at Kolobeng, where I had gone to the forest for some timber. Standing by a tree, a native looked behind me, and exclaimed, "There is the nest of a korwé!" I saw a slit only about half an inch wide, and three or four inches long, in a slight hollow of the tree. Thinking the word korwé denoted some small animal, I waited with interest to see what he would extract. He broke the clay which surrounded the slit, put his arm into the hole, and brought out a red-beaked hornbill, which he killed. He informed me that when the female enters her nest, she submits to a real confinement. The male plasters up the entrance, leaving only a narrow slit by which to feed his mate, and which exactly suits the form of his beak. The female makes a nest of her own feathers, lays her eggs, hatches them, and remains with the young till they are fully fledged. During all this time, which is stated to be two or three months, the male continues to feed her and her young family. The prisoner generally becomes quite fat, and is esteemed a very dainty morsel by the natives, while the poor slave of a husband gets so lean, that, on the sudden lowering of the temperature, which sometimes happens after a fall of rain, he is benumbed, falls down and dies.

"I never had an opportunity of ascertaining the actual length of the confinement, but on passing the same tree at Kolobeng, about eight days afterwards, the hole was plastered up again, as if, in the short time that had elapsed, the disconsolate husband had secured another wife. We did not disturb her, and my duties prevented me from returning to the spot. This (February) is the month in which the female enters the nest. We had seen one of these, as before mentioned, with the plastering not quite finished; we saw many completed, and we received the very same account here, that we did at Kolobeng, viz., that the bird comes forth, when the young are fully fledged, at the period when the corn is ripe; indeed, her appearance abroad with her young, is one of the signs the natives have of knowing when it ought to be so. As that is about the end of April, the time is between two and three months. She is said sometimes to hatch two eggs, and when the young of these are fully fledged the other two are just out of the egg-shells; she then leaves the nest with the two elder, and both male and female attend to the wants of the young which are left. On several occasions I observed a branch bearing the marks of the male having often sat upon it, while feeding his mate; and the excreta (from the female) had been expelled a full yard from

* The barbarous word Tockus would have looked more like Latin had the letter *k* been omitted, or a *c* put in its place.

the orifice, often proving a means of discovering the retreat." (Chap. xxx.)



Young Hornbill.

In continental India, there are several species, as *Buceros birostris*, *B. galeritus*, *B. Tickelli*, etc., but it does not appear that their habits of incubation are definitely ascertained. They tenant the topmost branches of gigantic trees. In some of the Tenasserim provinces, many of the trees rise to 150 feet before producing a branch, their summits attaining to a height of 230 feet, and upwards. It is on these giants of the forest that the *Buceros Tickelli* reposes and feeds; associating in pairs, or small parties of five or six, incessantly calling to each other in loud plaintive screams, "*whê-wheyo, whê-wheyo;*" and, when feeding, keeping up a low murmuring, like parrots.

We figure the head of a young and an adult specimen of the Rhinoceros Hornbill. In the young bird a portion of the horny plate or sheathing of the upper mandible is neatly cut away, so as to show the cancellated structure of the interior. The head, moreover, is somewhat turned, in order that the longitudinal division-plate down the centre, running from between the cavity of the nostrils to the tip, may be brought into fair view. This species measures in the length of the beak, from tip to eye, about ten inches; from the eye to the end of the tail, two feet six inches. The Concave Hornbill is much larger; the beak measuring twelve inches, and the length from the eye to the end of the tail, three feet four inches. Both are natives of India and the principal islands of the Indian archipelago.

Adult Hornbill.

W. C. L. Martin.

CHEMISTRY OF THE GASES.

WE have already made acquaintance with oxygen in our simple laboratory, and noted therein some of its peculiar properties. A whole tribe of elements wait their turn to disport themselves for our amusement; and though the springtide has thousands of outdoor recreations for the student of science, yet perchance some dull or showery day may render the chemist's workshop attractive.

We will call forth another gas as wonderful in its properties as the one we last investigated. It is imprisoned in the water we constantly use, and from that source shall we derive our second elementary substance —hydrogen. We shall require our homely trough and the gas bottles we used in the former experiments; but in order to make this gas we shall need a vessel somewhat different in shape from the one we employed for oxygen. We may take any small bottle (say about a pint size), which is made

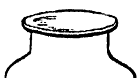


FIG. 8.

of tolerably thin material, has a pretty wide mouth, and approximates in shape to Fig. 8. To this bottle we must fit accurately a sound cork by careful cutting and filing. A delivery-tube of the shape shown in Fig. 1 (page 321) must be inserted through the cork, but not in the middle, as space must be left for another tube. This second tube must be a long glass funnel passing sufficiently far through the cork to reach nearly to the bottom of the vessel. The apparatus will now have the appearance of Fig. 9. When the tubes are both properly inserted, the top of the cork, together with a portion of the side, should be carefully sealed with wax to stop up any little holes through which the gas might escape, and to fix in the tubes more securely. This form of apparatus will be useful in the preparation of many gases which do not require the application of heat. We must next procure some granulated zinc.

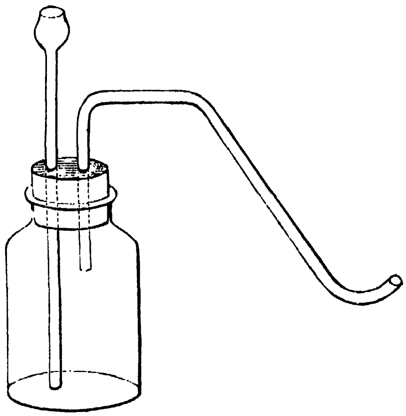


FIG. 9.

This is easily made by melting some scraps ot zinc in an iron ladle, and pouring the metal, from a height of two or three feet, into a pail of cold water. We may pour off the water, and keep the zinc in a bottle for the purpose of hydrogen manufacture. Having now arranged our gas jars and pneumatic trough in the most convenient manner, we pour water into the gas-generator till it is about one-third full; we then introduce a small quantity of zinc, and carefully replace the cork, applying a little lute of common soap or linseed meal if the joints do not appear air-tight. We next fill some of the jars with water, and arrange the delivery-tube from the retort in such a way that the end may dip into the water of the trough sufficiently deep to be below the shelf. If our retort should be too high to allow of this, we must raise the trough on a couple of bricks; but if

the tube dips too deep into the water, the retort must be placed on a block of wood. Such blocks, about three inches square and of various thicknesses, are always useful in the chemist's workshop. It is very important that the adjustments above mentioned be carefully attended to, as want of success is often the consequence of inattention to these small matters of detail. There is the zinc at perfect rest in the limpid water, though it has a great tendency to unite with the oxygen which the water contains, and thus become an oxide. How shall he start this operation? We will add some sulphuric acid to the water through the glass funnel, and we shall soon perceive a change taking place within the vessel. Bells of gas are evolved rapidly from the surface of the zinc, and escape by the delivery-tube. We will allow the action to go on for a short time before we collect the gas, or we shall have it mixed with the atmospheric air which was contained in the retort; and when we apply a light by and by we may have an explosion. Perhaps the safest way is to collect the gas from the commencement, and then to discard the first jar as impure. A wonderful change is now going on in those glass walls. The water we put in the flask is being broken up into its constituent parts—oxygen and hydrogen. The zinc is taking the oxygen to itself, and then it is being acted upon by the acid, so that sulphate (of the oxide) of zinc is formed in the flask, while free hydrogen escapes and is being collected at the trough. We might have used iron instead of the zinc; but the gas so obtained would not have been so pure as by this process.

In appearance we see this gas resembles oxygen or common air. It is transparent, has no colour, and, had we made it with perfectly pure materials, it would have no odour. We will endeavour, by experiments, to find out some of its most important properties. Into this jar we will plunge a lighted taper, which we find is extinguished; but the gas itself burns with a pale yellow flame; it is inflammable. We will next invert a jar and pass a light up into it. The light goes out as before, and the gas is kindled; but the combustion is very slow, and the flame faint. Some time will elapse before all the gas which the jar contains is consumed. We deduce from these two experiments that hydrogen is much lighter than air, and perhaps our next experiment will demonstrate this more clearly. We have here a bladder (Fig. 10), fitted with a stopcock and a small brass

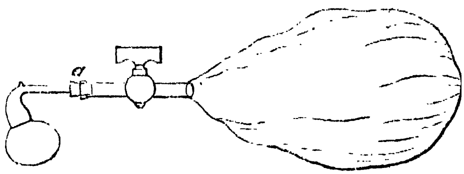


FIG. 10.

tube. We will squeeze out the air, open the stopcock, and attach the tube *a* to the delivery-tube of the retort (Fig. 9) by means of a piece of flexible tubing. We may thus collect a bladderful of hydrogen; but while that is being done we will prepare some good soapsuds, such, indeed, as will enable us to blow the kind of bubbles we did years agone. We have only to fit in the bowl of an ordinary clay pipe by means of a cork, and the bladder of hydrogen is ready for use. See that beautiful bubble which expands to a stately globe, and, then leaving the pipe, rises rapidly to the ceiling. Hydrogen is, without doubt, much lighter than common air. We may vary this experiment by filling a small balloon (about a foot in diameter) with the gas. We must, however, in this case take the precaution to dry the gas by passing it through a tube containing quicklime, which will absorb the moisture. We may find a broken lamp-glass answer our purpose very well, when we have cut the broken end off evenly and fused the rough edge with the blow-pipe, so as to prevent its cracking. We must fit

both ends with a good cork, through which a piece of quill tube must be inserted, and the bottom one bent at right angles. We can tie the tube, when filled with lime, to any convenient support, attach the balloon at the top with a piece of cotton, and connect the drying apparatus with the delivery-tube of the gas-generator by means of a piece of elastic tubing (Fig. 11). When full our bal-

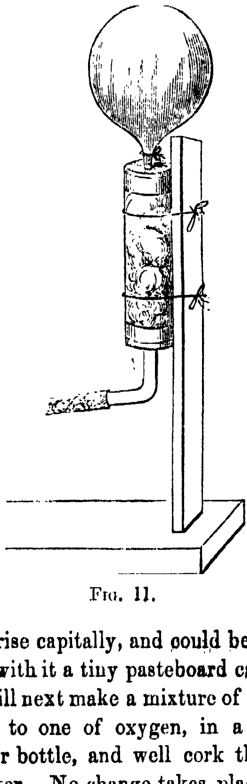


FIG. 11.

loon will rise capitally, and could be made to carry up with it a tiny pasteboard car.

We will next make a mixture of two parts hydrogen to one of oxygen, in a common soda-water bottle, and well cork the vessel under water. No change takes place in the vessel, though the two gases are intimately mixed; but if we apply a light we determine their union at once. Before doing this it may be advisable to wrap the bottle in a coarse cloth for fear of any mishap. On withdrawing the cork and applying the light we have a loud explosion, accompanied with the evolution of light and heat. The result of this chemical combination between the two elements is the production of a few particles of water. By using proper apparatus we could easily burn the mixed gases at a jet, and by placing a piece of lime in the flame obtain a most brilliant light; but we cannot well do this in a homely way without danger.

We may burn the gas at a jet as it is produced; but for this purpose it will be better to use a Florence flask, fitted with a cork and quill tube about eight inches long. The upper end may be drawn out a little so as to make the aperture smaller. Fixed in two rings of the retort-stand, and supplied with the materials for generating the gas, we shall soon have sufficient hydrogen to burn at the jet (see Fig. 12). We must, however, be careful to have the flask three-fourths full of the acid mixture, and must also allow sufficient time for the atmospheric air to escape before we attempt to kindle the gas. We will hold a tumbler, or large glass jar, over

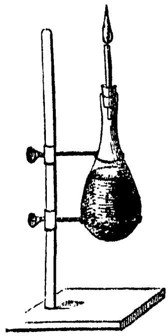


FIG. 12.

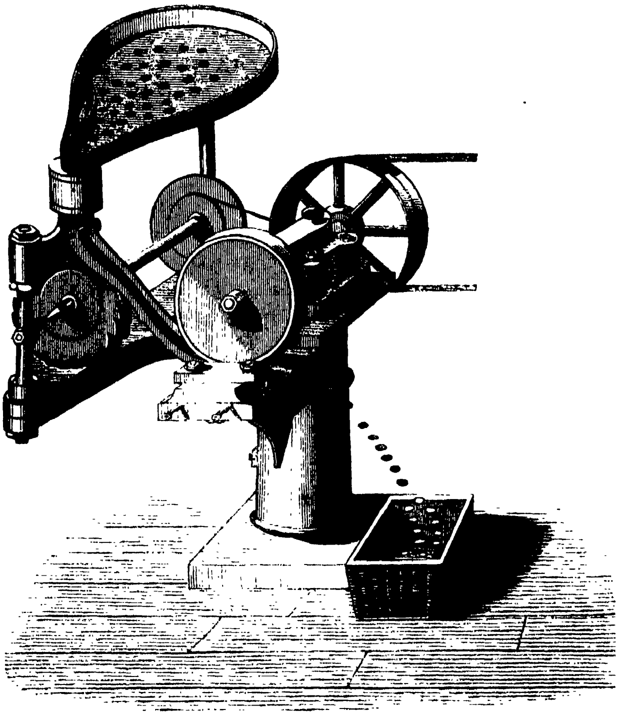
the faint yellow flame, and we find that it becomes rapidly covered with small particles of water, which have formed by the union of the hydrogen with the oxygen of the air.

But now we will draw the curtain, good fellow-student, and leave the workshop a while for the field, the beach, or the glen; but in any of these places you will meet our two acquaintances, hardly recognizable perhaps, but not the less assiduously at work, fulfilling their many tasks. In the early morning you may see the loving sisters hanging in pearly drops of dew on the tender blades of grass, though if you seek them at noonday they will have gone aloft to the fleecy clouds that canopy the blue vault

o'erhead. You will find the crystal drops coursing through the tissues of every living thing. You may hear the gentle murmur of the congregated particles leaping down the dale, or you may gaze on the wide expanse of ocean, where unnumbered atoms of oxygen and hydrogen are held fast bound in the chains of chemical combination; and as you watch each advancing wave break on the shore, you will, perchance, say that an hour in the chemist's workshop has added yet somewhat to the pleasure with which the intelligent eye may behold the works of God.

JOHN JONES.

Trindle Terrace, Dudley.



Marking Machine.

GOLD FROM THE CRUCIBLE TO THE COINING-PRESS.

It is calculated that there are in existence at this moment one hundred millions of sovereigns, and that about five millions per annum become "light." In order, therefore, to keep up the supply of coins of full weight, and thus to compensate for the wear and tear of circulation, the British Mint issues at present on an average about five

millions of new sovereigns yearly. Into the question of what becomes of the gold which is every year abraded from the surfaces and edges of our gold coins, and which amounts in value to £100,000, it is not our intention now to go. That it does not cease to exist is certain, and that its re-collection is impossible is equally so. To speculate upon its whereabouts might lead us into a lengthened dissertation, but would not result in any practical conclusion. We content ourselves, therefore, with simply stating the fact, and shall proceed to describe the means adopted in order to replace the coins which annually become light and are relegated to the crucible.

It must be explained primarily that the wants of the Bank of England govern the movements of the Mint machinery. When from political causes, fluctuations in foreign rates of exchange, or other circumstances, a drain of gold coin from the coffers of the Bank is induced, a portion of the bullion always lying in the vaults of that establishment is despatched to the Mint for conversion into sovereigns and half-sovereigns. It will be desirable for our purpose merely to suppose that from having an accumulation of light gold, or from experiencing an efflux of coins from its strongholds, the Bank has determined to import gold into the Mint for coinage, and then to trace its progress through the latter place. The gold so imported would have previously passed through the hands of the Bank refiners, Messrs. Brown and Wingrove, of Wood Street, Cheapside, and been brought very nearly to the requisite standard of fineness. Cast by this firm into ingots of about eight inches in length, three inches in width, and one inch in thickness, the bullion is ready for transference to the Royal Mint. Each of these ingots represents in value eight hundred pounds sterling, and very choice-looking "nuggets" they are.

Every million sterling in value of golden ingots is divided, when destined for coinage, into fourteen "importations," and the collective weight of these is 10 tons 14 cwts. 0 qrs. 14 lbs. 2 ozs. Imagining now that by means of common carriers' waggons—guarded, not, as in times past they were, by detachments of soldiers, but by an escort of two or three Bank porters—a million's worth of ingots have been transferred to the Mint, we shall take the liberty of explaining what is there done with them. In the first place, their weight is carefully noted, and in the next a corner is cut from each ingot by means of a "cold chisel" and hammer. These cuttings are forwarded to the assayer, who, by the ordinary chemical tests, ascertains the amount of the "betterness" or "worseness" than standard gold of the ingots from which they have been obtained. The assayer's report governs the action of the officer of meltings, to whose hands, after exact weighing, a batch of the ingots are committed. That gentleman signs a receipt for the weight of metal entrusted to him, and now it is ready for the melting-house and the crucibles.

The gold melting-house of the Mint is situate immediately at the back of the handsome stone edifice which faces the Tower. It forms the left wing of the coining-rooms, and is connected with the central office by an iron tramway, which was constructed probably before Mr. Train, of tramway celebrity, was born. Down this tramway, in strong omnibus trucks, the melter causes his workman to convey his precious charge; and arrived therewith at the melting-house, the whole of the ingots are passed once again through scales. These frequent weighments, conducted on the decimal system, are necessary as checks and safeguards, as will hereafter be shown. The melter having ascertained and noted in his journal the precise weight, to the one hundredth part of an ounce, of the ingots, delivers them into the hands of his workmen. These latter remove the wedges of gold to the furnaces. There are seven of these, and

each, at the time for melting, has a crucible of plumbago placed on it, on a coke bed. The heat of these furnaces of course is intense. In times of pressure as many as fifty crucibles of gold have been passed through the furnaces in a single day, and, as six ingots constitute one "charge," it is clear that the value of the day's melting in that case was £250,000. Let us, however, confine ourselves to the present. In companies of six, the ingots are placed in the crucibles together, with as much fine gold, or copper, as the assayer's report warrants, for the purpose of raising, or reducing, the mass to standard. A short time suffices to convert the rigid nuggets into a fluid state, and gradually they subside and disappear in the bottom of the crucibles. The moulds are meanwhile prepared for the reception of the rich liquid. They are made of cast-iron, rebated from end to end in a planing machine, and being formed in "two halves," are easily put together, or separated. A row of these moulds are ranged vertically on an iron frame, and strong bars of iron unite them firmly together during the time of pouring. Let us now suppose the metal in the crucibles to be thoroughly fused, the moulds in readiness, the workmen ready, and all minor appointments made. Well, crucible No. 1, by the aid of a kind of iron pump-handle, or lever, suspended from the ceiling, and having attached to it a ring, is now lifted from its fiery seat and guided by a workman to the mouth of the first mould. The weight of the crucible and its contents is partly taken off the hands of the pourer by means of an iron hook dependent from the roof. He has little power to exert, save that necessary for directing the "lip" of the crucible to the mouth of the mould, and to pour a portion of the charge into it. Practice enables the caster of gold-bars for coinage to judge with great accuracy as to the gate at which to deliver the molten gold, and his ear informs him when the mould is full. Just, indeed, as the bottler off of golden sherry can determine by ear when the wine has reached the neck of the bottle he is filling, so does the operator in question at the Mint learn, by the varying sound of the still richer fluid with which he deals, when his mould is full enough. One by one the whole of the moulds on one mould-frame is filled, and then another frame is made to take its place. The operation of filling series after series of moulds until the whole of the ingots are disposed of goes on, and then the moulds are separated. If the bars are not quite cold they are plunged one after the other into a cold-water bath, and then placed side by side on an iron-faced bench. If they display any unevenness, or are at all jagged at the edges, they are trimmed with a steel chisel.

The mode of casting bars for half-sovereigns is precisely similar to that for sovereigns, but the moulds are slightly smaller. In the shape to which the ingots have now been brought they are ready for the next operation, that of rolling, and the precise dimensions of the bars at this time are, for

	Length.	Breadth.	Thickness.
Sovereigns . .	21 in.	$1\frac{3}{4}$ in.	1 in.
Half-sovereigns	24 „	$1\frac{1}{4}$ „	1 „

The melter now weighs the results of his day's work, together with all chips and scraps of the precious material. The crucibles are examined to ascertain whether they have absorbed any portion of the fused metal, and, indeed, a most scrupulous balancing up of the day's work takes place. The melter thus ascertains the amount of working waste or loss which has arisen from volatilization or other cause, and assures himself that dishonesty has not taken place.

The rectangular bars of gold are now lettered, so as to preserve their identity, and assay pieces are cut from each so as to make assurance doubly sure in regard to their standard of fineness. This standard, we need scarcely add, is attained when the assay gives as the proportions 22 parts of fine gold to two parts of copper alloy. After this assay the

accepted bars are transferred once more to the Great Office of receipt and delivery, and here the chief coiner or his deputy receives them, once more through the scales, writes a receipt for them, and transmits them, per tramway and trucks, to the great rolling-room. This is a noble apartment, about 70 feet in length, perhaps fifty broad, and thirty feet in height. The machinery in it consists of six pairs of laminating rollers, of sizes varying from fourteen inches in diameter down to ten, and having surfaces as hard as steel, and as bright as the cuirasses of her Majesty's horse-guards on a review day.

Besides the six pairs of rolls in their massive frames of cast-iron—which stand six feet high, and are firmly bolted to the granite pavement—there are two pairs of steel circular-shears, and the whole are driven by subterranean shafts and geared-wheels. The rolls are used indiscriminately for gold and silver, the shears for copper only. In the same apartment there are annealing ovens, annealing carriages, cranes, trucks, and all other fitments necessary for carrying on the operations. A steam-engine of forty-horse power propels the whole of the machinery, but is not visible from the room.

We may now return to the gold-bars, which await our attention, and that of the money-makers. Again they are weighed in large scales suspended in an adjoining office, the officer in charge noting their precise weight in his day-book. Next they are handed over to the workmen who superintend the largest or "breaking-down" rolls. The overman adjusts these by means of two indexed adjusting screws, which pass through the mill-frames. The index serves to point out the distance between the upper and lower rolls, and this is regulated by the thickness of the bars. Supposing now the rolls to be in motion, the bars are taken up singly by the overman and placed between the running rolls. These at once receive the proffered food, and it passes rapidly between them. A workman is ready to catch the bars as they are delivered from the mill, and now they are found to be considerably longer and thinner than when they left the moulds. This is, therefore, the first step in the laminating process. Now the rolls are brought into nearer proximity by means of the adjusting screws, and the whole series of bars are once more passed between them. This second squeezing ordeal has the effect of yet further attenuating the bars; and another, and another repetition of it reduces them to about the thickness of an old copper penny. The compression, however, has made the metal very hard, and it must be annealed. In order to accomplish this the bars are cut by aid of shears into short lengths, and then put into copper tubes. Sealed up in these they are committed, on iron carriages, to the annealing ovens. Half an hour's cooking is sufficient to soften them, and after cooling in water they are almost as plastic as lead. Now they are passed on to mills of smaller size, and, by another succession of pinches, are reduced in thickness until the application of a graduated steel gauge shows them to be but slightly thicker than a sovereign. They now are no longer bars, but ribands, or, technically, "fillets" of gold, and are about four or five feet in length. Their width is just such that two sovereigns may be punched from end to end of them in tiers.

The operations of the rolling-room cease at this point, and the whole of the work is weighed up before being transferred to the adjusting-room. Allowing that the balance is struck, and that no particle of metal is missing, the whole of the fillets are entrusted to the care of the next officer. Waste ends, scraps and *débris* of all kinds, are deposited in a trebly-locked stronghold, for return to the melting-room.

The adjusting-room has its under-ground shafts, straps, and pulleys, and they are driven by a twenty-horse power steam-engine, placed at a convenient distance. In

this apartment there are draw-benches, small rolls, and shears, with certain hand test-punches. The draw-benches are receptacles for cylinders of hardened and polished steel, three-quarters of an inch in diameter and three inches long. The cylinders are placed horizontally in pairs, one above the other, and the distance between each pair is precisely the thickness of a sovereign. Between these, therefore, each fillet is forcibly drawn by an ingenious arrangement of mechanism, and by the process they are brought to the exact thickness required. A piece is punched here and there by means of the hand test-punches, and weighed. The weighing is a constant check upon the machines, and the instant these become erratic, a readjustment of them is made. The accepted fillets are now ready for the cutting-out presses, and of these there are twelve, awaiting them in the cutting-press room. They are ranged above a circular platform, at a convenient height from the floor, and twelve boys are their attendants. Each press is fitted with a punch, which may be made to rise and fall self-actingly, or brought to a sudden standstill at the will of its attendant sprite. These punches are made of the finest cast-steel, and are turned to a gauge of slightly larger diameter than the coin to be produced.

Beside each boy, in a tray, is placed a batch of gauged fillets of gold, and when all is ready the youthful coiner, by pressing with one foot on a treadle or pedal, as it might be termed, puts his press in motion. The punch ascends and descends at a speed which allows sixty perforations to be made in each fillet per minute, the boy taking care to supply the material. The pellets or discs of gold fall into boxes recessed into the platform beneath the presses. Sample pieces are continually taken from these drawers and weighed, because the slightest alteration in the working of the punches would interfere most mischievously with the exactitude of the coins to be produced. The attendant boys have only to remove their feet from the pedals of the rather unmusical instruments with which they have to deal, and the clatter of the presses ceases instantly. Two hundred thousand sovereigns or half-sovereigns can be cut per day at the Mint, but it is seldom that so large a quantity is required.

Imagining here that the whole of the fillets forwarded to the cutting-out room have been perforated with as little waste as possible, the next operation will be to collect the resulting "blanks," and weigh them. This is done in batches of 720 oz., or in numbers of 2804—supposing them to be sovereigns—and they are next deposited in bags containing also tickets of their weight to the one-hundredth of an ounce. The perforated fillets, now denominated "scissell"—a term peculiar to the Mint—are also bound, by aid of a compressing machine, in bundles and weighed. Duly ticketed, these are placed in trucks for relegation to the melting crucibles, whilst the blanks are transmitted to the weighing-room. Thither we would, in imagination, conduct the reader, and here are, indeed, to be found ample proofs of the advancement of mechanical skill. It will be readily comprehended that in so delicate an operation as that of weighing singly sovereign blanks—which must not vary more than one-quarter of a grain above or below a certain weight—that excessive care is required. Formerly, this individual testing of gold pieces was performed by a staff of twenty men, supplied with apothecary-like hand-balances; but automaton machines of the most accurate workmanship, made by Napier, have now superseded the living weighers, whose "occupation is gone." Thirteen of these instruments, a little larger than drawing-room clocks, fitted up more carefully, and costing £200 each, are arranged, for the convenience of good light, on one side the room. Motion is given to them from a small bright iron shaft, revolving noiselessly above, impelled by a miniature engine worked by the pressure

of the atmosphere. Friction pulleys, over which the driving bands, not thicker than fiddle-strings, and composed of the same substance, are placed on the spindles of the automaton balances, and these enable the attendant, by pressure of thumb and finger, to stop the action of either machine at a moment's notice. Taking at first a general view at these mute judges of the quality of the work done by the Mint, we may afterwards examine one of the family more minutely.

We observe that it is fitted with a long brass semicircular conducting-tube, or spout, placed at a sufficient angle of inclination to cause the pieces of gold to pass down gently, by the law of gravitation, towards the tiny scale-table at its base. If we examine one of the machines minutely, we shall observe that a small slide of polished steel, of the thickness of a sovereign, is continually advancing and receding at the foot of the feeding-tube, motion being given to it by a "cam" in the interior of the case. Every time the slide advances, which is once every three seconds, it pushes before it the lowest golden piece in the feeder, and leaves it with gentle exactness on the scale-table, which is also of polished steel, quite flat, and a little larger in diameter than the blank. On this table for the space of three seconds each candidate for sovereignty rests, and this is the critical moment of its existence, literally the turning point of its destiny. In this space of time its weight is taken, and its fate, or fortune told. The beam of the weighing-machine is beneath the scale, and it is a piece of the most delicate mechanism. It is about eight inches in length, of hardened steel, and of fairy-like dimensions. Poised upon knife edges of the same material, and which rest upon planes of steel, it will turn freely with the weight of a small portion of a single human hair. Dependent from the opposite ends of the beam to that upon which the blank rests is a rod, or fine wire rather, terminating in a miniature stirrup. This stirrup contains a glass disc of the exact weight of a sovereign, minus one-quarter of a grain, which is the "remedy" allowed by law for variation below the standard weight. If the piece of gold deposited on the scale-table be of sufficient weight to keep the beam in a state of equilibrium, well and good, the slide, advancing with another novice for probation, pushes the weighed piece unceremoniously over a precipice which leads to the "accepted" compartment. If, however, it is raised by the counterpoise it is too light, and the precipice conducts it to the limbo of the "rejected." Should it be too heavy, and lift the counterpoise and a piece of fine platinum wire, weighing half a grain, into the bargain, it is sure to be deposited in the too-heavy box. Thus is each piece of gold submitted to these silent judges, tried on its own merits, and its future prospects made or marred by their just decisions.

Two hundred thousand blanks may be passed through this ordeal in the course of a day, when the whole of the automaton balances are in action, and so exactly are the operations of the Mint conducted at present, that not more than three per cent. pass into the "rejected" compartments. The importance of obtaining so large a per centage of good work will be readily comprehended when it is known that the rejected are, for the most part, returned to the melting crucible, and have to pass through the whole of the preliminary processes again. We say, "for the most part," because latterly a filing and scraping machine, contrived by the officer of the weighing-room, has been employed for abrading the edges of the too heavy blanks, and thus saving many of them from an ignominious doom.

Allowing now that an entire batch of golden blanks have been weighed, and not found in any respect "wanting," they are collected, placed in bags, containing 720 ounces each, ticketed with their exact weight to the hundredth part of an ounce, and sent for-

ward to the "marking-room." In this department there are eight machines, with a recently-invented one which promises to eclipse all the others in accuracy of performance and in rapidity of action. It was invented by an artificer of the establishment, and its use and nature we shall briefly explain.

It will be necessary, however, first to state what the operation of "marking" really means. All will have observed that sovereigns and half-sovereigns, as indeed all other coins, have a protecting edge or rim around their circumferences. Thus, while it forms a sort of frame and finish to the pictures on the coin, saves them, to a great extent, from abrasion. The marking process raises these edges on the blanks before coining, and thus prepares them for the reception of the ornamental beading by which those edges are finally decorated. The new machine of Mr. M. Jones, of which we furnish an illustration, at page 234, effects this object with great rapidity. The blanks are deposited in the feeding-pan, which, placed at an angle, conducts them naturally to a tube at its foot. An assistant takes care that this tube is filled with regularity. Below the tube is placed a wheel with serrations on its outer circumference. When the machine is put in motion, each of these serrations, as it passes below the feeding-tube, catches and marches forward a blank, which falls down a spout leading to a revolving steel disc, with a groove on its surface. A steel check, with a groove corresponding to that on the disc, is fixed in front of the latter. It will now be clear that the pieces of gold, as they descend in succession to the grooves, will be made to revolve two or three times between those grooves, and getting their edges thus compressed or raised in the operation, will fall "marked" into the basket. The diameter of the blanks is, of course, determined by the distance between the revolving disc and the fixed check. There are means of adjusting this machine to suit the varied sizes of the entire forms of British coins. After the marking process has been thus satisfactorily accomplished, the pieces of gold are removed to the annealing-room. This apartment contains eight ovens, heated by as many "Juckes's" smoke-consuming furnaces.

It is necessary to soften the blanks to the fullest extent possible, above the fusing point, before they are advanced to the stamping department, and this is effected in the following manner:—The workman, in the first instance, discharges a portion of the contents of one bag of blanks into a mahogany ranging tray. This is a sort of open box, about two feet six inches in length, nine inches in breadth and two inches in depth, with a series of longitudinal flutings in it. By shaking this box and its golden contents dexterously, the workman causes the blanks to range themselves on edge in *rouleaux* in the flutings. The annealing-box is next called into requisition, and this is of cast-iron. It is of just sufficient capacity to receive the *rouleaux*, which make up in number 2804 blanks, and to allow room for their expansion in the process of annealing. Supposing one of these, which will answer as a description of the whole, filled with blanks from the ranging tray, the next operation will be to confine the pieces of gold in their purgatorial cell. In order to accomplish this, the boxes are covered by two plates of wrought-iron. These are carefully luted over with fire-clay, for the purpose of excluding the air during the heating process, and preventing volatilization. If the first were not effected, oxidation, and consequent discoloration, would take place, and if the second, loss of weight would follow.

The oven being brought to a proper heat, a small iron carriage is placed upon an iron table in front of it, and upon this carriage is deposited the box of gold, a veritable Royal Mint pie. The carriage, running upon small iron wheels, is now backed into the oven, and

the door, balanced by counterpoise weights, closes its mouth. The annealor, through a peephole in the oven-door, watches the progress of the baking. About forty minutes is sufficient time for cooking a pie of this nature. While this operation is going on, it may be told, by way of gossip, that some thirty odd years ago a workman in this department of the Mint, instead of putting one of the usual batches of 280*l.* blanks into the oven, by an error of judgment, or something much worse, put it into his pockets, and, under pretence of seeking refreshment, disappeared with the gold for ever. The fate of the thief was never accurately learnt, nor were the proceeds of the robbery traced. It has been surmised, however, that outdoor confederates, by the commission of a far more heinous crime, possessed themselves of the treasure, and that their instrument in effecting the theft did not survive the day on which he accomplished it!

We leave this little "mystery of the Mint," to return to the annealing of our blanks. The box in which they are inclosed is withdrawn at a cherry-red heat from the oven, and deposited on the stone-floor to cool. Twenty minutes suffice for this, and the lids are removed. The box is next inverted over a copper dish with handles to it, and into this the blanks fall. The dish is carried forward to the blanching-room, and its contents transferred to a copper cullender, placed beneath a cold-water tap. A douche-bath completes the cooling of the gold, and frees it from any particles of burnt clay which may have inadvertently intruded themselves among it. And now comes the pickling process. A cast-iron copper—may the Hibernianism be pardoned! —a cast-iron copper, lined with lead, and nearly filled with a weak but boiling hot solution of sulphuric acid, is at hand to receive the candidates for coinage, and into this, cullender and all, they are put. The —*cook*, we had almost said—the workman, we mean, stirs them up with an ashen staff, and this brings all their faces into contact with the pickle. A very little of this treatment suffices for the patients, and they are again removed and *douched* in cold water, to free them from all traces of acid. The change in their appearance now is marvellously for the better. Instead of the dull, brassy, spiritless aspect they bore before the oven and the acid had done their work, they are now gay, golden, and spirited-looking, and in colour each piece is "every inch a" sovereign, if not a "king." A very slight diminution in their weight results from these fiery and watery ordeals, but that is from the loss of alloy, not of gold.

After the bathing, the drying process naturally follows, and this is effected on a hot-iron plate, and in a copper muffle. The plate is covered by a layer of beech-wood saw-dust, and into a sieve filled with this material the cullender is made to discharge its contents. Absorption and hand-friction quickly do their part of the work; and then the muffle, which is a kind of coffee-roaster, moved briskly in a heated cylinder of iron, completes it. The pieces are now perfectly soft, clean, dry, and prepared to receive impressions. The processes which we have endeavoured to describe in regard to one bag of gold are followed in regard to *all*, in passing through this department; and after these processes are effected, a careful weighing-up takes place, and a notification of the loss resulting from them is made. Weighing is, indeed, the sheet-anchor of officers of the coining department—their protection from the lee-shore of peculation—a word the meaning of which, thanks to Dr. Graham's excellent management, is now, however, unknown in the Mint.

The blanks are now, therefore, prepared, as has been said, for the stamping process, and this is effected in the *coining-press room*. In this noble apartment, which is 70 feet in length, 35 feet in breadth, and about 20 feet in height, there are ranged in a single line

eight coining-presses. These occupy a position above an iron platform, in which recesses are made for the reception of as many boys to attend and feed the machines. Among these juvenile coiners the blanks are distributed, and in each press are affixed a pair of dies. Supposing that the skilled and skilful artificers of the Mint have previously adjusted the presses, the boys commence their operations by filling the feeding-tubes with *rouleaux* of blanks. For the sake of clearness of description, perhaps it will be best to take for present illustration one press only.

The boy at press No. 1, for example, having filled the tube, causes a mechanical thumb and finger to advance from below it, with a single piece of gold. This is carried, with great exactness, to the lower or obverse die. He next attaches the thumb and finger to a mechanical arm and elbow, and then pulls quickly a line placed at his right hand. The effect is sudden and sharp; the upper or reverse die descends rapidly; the thumb and finger retreat, as if to save themselves from accident; a steel collar, which fits the lower die accurately, and is milled or grained on its inner circumference, rises and incloses the piece of gold, and lo! the latter is stamped on both sides, and has its edge serrated. One blow has done all. The press continues vibration under the impulse of concealed pneumatic machinery; the thumb and finger advance with another piece of gold; the collar of steel descends; the coined piece is pushed away, to make room for a successor; this receives the blow of the reverse die, is compressed with giant force between the two dies, moulded in the serrated collar, and pushed forward for examination into a copper pan placed to receive it and its brother sovereigns; and thus, amid considerable noise, does the operation of stamping go on. The *power* given to the presses is derived directly from the atmosphere, and it may be modulated to the greatest nicety. Whether it be necessary to strike Crimean medals or threepenny pieces, the arrangement is equally simple. A double-acting air-pump, placed beneath the beam of a steam-engine, exhausts a vacuum chamber at the back of the stamping-presses. These are connected with the chamber by means of a series of eight small open cylinders, in which pistons move vertically. The communication between the cylinders and the vacuum chamber is made in each case by pneumatic valves. There are, besides, levers, springs, counterpoises, rods, and other mechanical appliances, which go to make the machines self-acting, whilst a barometer-gauge and relief-valve regulate the extent of pressure.

Returning to the presses, we find, in passing them in review, that each is delivering itself of coins at the rate of over sixty per minute, and on examining the latter that they are perfectly bright, from the high polish of the dies, and ready to be issued for general circulation. After this, the closing scene in the progress of "gold from the crucible to the coining-press," it is only necessary to say, further, that the coined sovereigns are made up in journey weights of 180 oz., or 701 pieces, and are thus transferred to the Bank for issue to the public.

JOSEPH NEWTON.

ALLOTROPISM.

THE term Allotropism has been applied by chemists to the phenomena presented by bodies appearing in different forms; such differences being either physical or chemical. It is to the ultimate cause of these differences of form, colour, density, conducting

power, and chemical affinity, that I would now direct your attention.

It may be well, before entering on an explanation of the cause, to give a few examples of some of the more remarkable cases of bodies assuming allotropic conditions.

Perhaps the most striking and well-known case is that of carbon, which assumes the three remarkable forms of lampblack, graphite or plumbago, and the diamond; these three conditions of the same body differing from one another most widely in external appearance, densities, degrees of hardness, powers of conducting heat and electricity, and of transmitting or absorbing heat and light, differing also in their specific heat and heat of combustion. From the every-day occurrence of one or more of these forms, and from the remarkable extent of the variation between them, this instance is more generally known than others scarcely less curious. We can, to a certain extent, transmute one form into another; thus, by the continued action of a high temperature, we may convert charcoal, or even the finely-divided lampblack, into the dense, hard, and brittle form of gas carbon, so much used in electrical experiments. Again, we may obtain crystals of carbon from masses of cast-iron, when cooling from a state of fusion; in this form it approaches nearer to that of the diamond than in any other we can produce. The diamond may be converted, by the passage of a powerful electric current through it, into the form of a black mass of graphite, which may be burnt in oxygen, producing carbonic acid gas (CO_2). Another remarkable instance of allotropism is that of phosphorus, which is usually seen in the form of white, waxy-looking, softish sticks, of so inflammable a nature, that when dry they will ignite at the temperature of a summer's day; yet these sticks may be converted, by exposing them to a heat of 442° Fahr., under circumstances in which they cannot ignite, into a brick-red amorphous looking mass, with far less affinity for oxygen, with a higher melting point, and which is insoluble in bisulphide of carbon—a liquid which, by the way, dissolves the common form with the greatest facility. Phosphorus may also be obtained in the form of distinct crystals, which retain the active properties of the white kind.

Sulphur also appears in many forms, as octahedral and prismatic crystals, as a tough, elastic, stringy body of an amber colour, which on long standing becomes brittle and opaque, and as an amorphous powder of dull amber, black, or blue colour. Sulphur is usually obtained of a bright yellow colour, but this may be changed, by the mere action of heat, to a deep brownish red, and on sudden cooling to an amber colour. We may obtain the blue sulphur by depositing it from sulphuretted hydrogen, which, however, loses its peculiar colour on long exposure to the air.

Then there are vast numbers of other cases of less importance, among such come the varying appearances presented by the same precipitate at different times, according as the precipitation takes place rapidly or slowly; thus, for example, oxide of mercury may appear as red, yellow, or brown, tersulphide of arsenic as light yellow or deep orange-brown, etc.

We see also the effect of water in modifying the colour of a body, as in salts of cobalt, which are pink in the hydrated condition, and blue in the anhydrous.

Besides these, we have among the gases the more doubtful case of ozone, which some eminent chemists consider to be an allotropic condition of oxygen, whilst others, equally eminent, consider it as a true chemical compound of oxygen and hydrogen; in fact, a teroxide of hydrogen (HO_3). I think, on an impartial study, the latter view will be found to have the greater mass of evidence in its favour.

Now, what is the cause of these wonderful transmutations of one form into another? It must, of course, lie in the body itself, and we must seek for it in the arrangement of the molecules of the body. If we first proceed to study the more obvious variations, such as those of colour, form, etc., we shall, I think, find that the arrangements of the particles of the bodies in the various cases, will fully account for all the differences. Take some clean transparent glass, for instance, and pound it in a mortar; it will gradually, as the particles get more and more finely divided, lose all its transparency, becoming perfectly opaque and white. This result is due to the little particles of glass, no longer regularly arrayed, reflecting and scattering the rays of light, instead of transmitting them; and it is also in part caused by the great quantity of air inclosed amongst them. The same reasoning will account for the difference in appearance between ice and snow. The question of colour may be solved by considering that the molecules, frequently forming little crystals, refract the light differently, when compactly aggregated together, from what they do when arranged loosely. This may be shown very nicely by spreading some freshly precipitated iodide of mercury on some paper, allowing it to dry, and then rubbing it with some hard body, when the colour will change from a bright yellow to a brilliant red; on holding this before the fire the red will gradually change back again to the yellow. On examining this with a lens, it is seen to be due to the formation of minute crystals, which are broken down by the rubbing.

There are three forms in which inorganic solid matter may arrange itself, viz., crystalline, vitreous or glassy, and amorphous. Now by the action of heat we can frequently, as shown above, cause a body to assume say one of these forms, that is, by applying the proper amount of heat, we can so separate the particles of a body from one another, that they rearrange themselves in some new form, which is dependent upon the forces exerted upon it externally. It has been shown, by many observers, that the forms of crystals are dependent on the directions of magnetic currents; and Mr. Crosse formed artificially several crystals, by the slow but prolonged action of electric currents on various solutions; so that we may have reason to hope that the black, soft, amorphous lampblack may be made to assume the transparent, colourless, hard, and crystalline form of the diamond.

The differences observable in the other physical properties of the various allotropic forms of bodies, such as their conducting powers, specific heat, etc., may be reduced to the same cause, viz., different arrangement of the ultimate molecules.

It is well known that the atoms of bodies are never in close proximity to one another; that even the densest substance has its atoms separated by spaces—infinitely minute, to be sure, but still not the less important—and that these spaces may be increased or diminished, according to the amount of force exercised by heat in overcoming the cohesion of the particles, so that, as the specific heat varies according to the density of the body, if such spaces be permanently enlarged by the repellant action of heat, the specific gravity of the body will be changed, and its specific heat altered accordingly. We have a case of this when the diamond, by the intense heat of electricity, is converted into graphite.

Variations in chemical properties may possibly be explained in a similar manner; for chemical affinity will frequently show itself when the particles of the bodies are in a sufficiently mobile condition. It is natural, therefore, that the molecules of carbon, in the dense compact form of the diamond, should be less capable of exercising their power of combination with

oxygen, than when in the widely-separated and loosely-connected form of ordinary charcoal. It must be confessed, however, that it is somewhat difficult to explain the fact of amorphous phosphorus being less active than the white and waxy form.

It may be a question, whether we are entitled to consider organic products, of precisely the same chemical composition, but differing widely in appearance and in physical and chemical properties, as allotropic modifications of the same body. Their differences must depend on the arrangement of the *ultimate atoms* of their constituent elements; and this, it appears to me, is but an extension of the principle on which allotropic conditions of bodies are explained. When the arrangement of the constituent atoms of such bodies as lignine, gun-cotton, starch, gum-arabic, tragacanthe, etc. (which all consist of $C_{12}\,H_{10}\,O_{10}$), is sufficiently disturbed, what do we get but carbon, hydrogen, and oxygen? We have not as yet been able to cotribute to recombine the elements, so as to produce even one of these forms; but, from the great and constantly increasing connection that is now shown to exist between inorganic and organic bodies, we may reasonably hope, that before long this may be effected. Urea but a short time ago was considered as a body producible only by living organisms, and now we can make it in our laboratories. This same urea ($C_2\,N_2\,H_4\,O_2$) is moreover a good example of the same elements, in the same proportions, combining to form two entirely different bodies, viz., urea and cyanate of ammonia (NH_4O, C_2NO). These some will not allow to be considered as allotropic modifications, though it appears to me that the difference is more one of degree than of kind.

To some extent analogous to these allotropic forms assumed by matter, are the different kinds of force which we see at work in Naturè. It is agreed by all that force cannot manifest itself without motion; light, heat, electricity, etc., are all forms of motion; the various manifestations being only the result of different kinds of undulations in an ethereal medium, which is supposed to pervade all space, even the spaces between the molecules of bodies.

It has been shown by Grove, Faraday, and many others, the physical forces are all modifications of one and the same force, and that force, upon this earth at least, is as indestructible as matter. It can, however, be modified, can be obtained in different forms, may exhibit, as matter does, the phenomena of allotropism. A. B.

METEOROLOGY OF OCTOBER.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Mean el... force of vapour ... he pressure d... o he water contai... i the air.	...ean pressure ... dry air, or the p... sure due to the g... of the air.	...e... we... in cul...	Mean degre... humi... dity 100 ... plet... saturation	Mean quantity ... w... in a vertical ... m... of the atmos...	... a ct ... air.
	Of an inch.	Inches.	Grs.		Inches.	Grs.
1848	0·327	29·209	3·9	0·84	4·7	529
1849	0·294	29·440	2·9	0·69	4·1	537
1850	0·279	29·411	3·2	0·85	3·9	539
1851	0·334	29·378	3·8	0·87	4·6	535
1852	0·270	29·432	3·1	0·84	3·7	540
1853	0·301	29·234	3·5	0·85	4·2	534
1854	0·262	29·418	3·0	0·77	3·7	538
1855	0·300	29·165	3·5	0·85	4·1	533
1856	0·322	29·661	3·6	0·87	4·5	543
1857	0·336	29·346	3·8	0·86	4·6	537
1858	0·289	29·524	3·3	0·82	4·0	542
1859	0·272	29·230	3·0	0·79	3·8	539
1860	0·298	29·495	3·3	0·81	4·1	540
Mean	0·299	29·380	3·4	0·82	4·2	537

The mean elastic force of vapour, *i. e.*, the pressure of the barometer due to the water contained in the air, is for October of the last thirteen years 0·299 of an inch (or three-tenths of an inch nearly); ranging between 0·262 of an inch in 1854, and 0·336 in 1857—a difference of ·074 of an inch.

The mean pressure of dry air, or the pressure due to the gases of the atmosphere at the height of 174 feet above the sea-level, for October of the last thirteen years, is 29·380 inches; ranging between 29·165 inches in 1855, and 29·661 inches in 1856—a difference of 0·496 of an inch.

The mean weight of vapour in a cubic foot for October, during the past thirteen years, is 3·4 grains; ranging between 2·9 grains in 1849, and 3·9 grains in 1848—a difference of 1 grain.

The mean degree of humidity (complete saturation being represented by 1·00) for October, during the past thirteen years, is 0·82°; ranging between 0·69° in 1849, and 0·87° in 1851 and 1856—a difference of 0·18°.

The mean whole amount of water in a vertical column of the atmosphere for October of the last thirteen years is 4·2 inches; ranging between 3·7 inches in 1852 and 1854, and 4·7 inches in 1848—a difference of 1 inch.

The mean weight of a cubic foot of air for October, during the past thirteen years, is 537 grains; ranging between 529 grains in 1848, and 543 grains in 1856—a difference of 14 grains. E. J. LOWE.

ASTRONOMICAL OBSERVATIONS FOR OCTOBER, 1861.

THE Sun is in the constellation of Libra until the 23rd, when he passes into that of Scorpio. He rises in London on the 1st at 6h. 2m., on the 10th at 6h. 19m., on the 20th at 6h. 34m., and on the 30th at 6h. 52m.; setting on the 1st at 5h. 37m., on the 10th at 5h. 17m., on the 20th at 4h. 55m., and on the 30th at 4h. 35m.

He rises in Edinburgh on the 9th at 6h. 18m., and on the 20th at 6h. 47m.; setting at Edinburgh on the 8th at 5h. 14m., and on the 20th at 4h. 44m.

He rises in Dublin on the 3rd at 6h. 7m., on the 11th at 6h. 21m., and on the 26th at 6h. 50m.; setting at Dublin on the 4th at 5h. 27m., on the 12th at 5h. 6m., and on the 27th at 4h. 35m.

The Sun is on the meridian in London on the 3rd at 11h. 48m. 59s.; on the 18th at 11h. 45m. 12s., and on the 28th at 11h. 43m. 58s.

The equation of time is on the 3rd, 11m. 1s., on the 18th, 14m. 48s., and on the 28th, 16m. 7s., the equation of time being addative.

Twilight ends on the 5th at 7h. 21m., on the 16th at 6h. 57m., and on the 31st at 6h. 28m.

Day breaks on the 4th at 4h. 13m., and on the 29th at 4h. 56m.

The Moon is new on the 4th at 6h. 56m. a.m.

Full Moon on the 18th at 6h. 38m. p.m.

She is at her nearest distance from the earth on the 5th, and is most remote on the 20th.

The planet Mercury is in Virgo at the beginning of the month, and at the borders of Libra and Scorpio at the close of the month. As he sets about the same time as the Sun, he will be scarcely visible to the unassisted eye during the month.

Venus is in Scorpio at the beginning of the month, and in that of Ophiuchus at the end of the month. Being so near the Sun she is scarcely visible.

Mars is in the constellation of Virgo throughout the month, and invisible.

Jupiter still remains in the constellation Leo during the month, and is becoming visible in the mornings, but he is still too near the Sun to allow of the eclipses being seen. He rises on the 1st at 3h. 25m., and on the 28th at 2h. 28m. a.m.

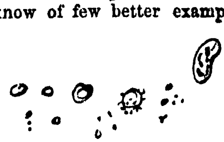
Saturn is also in Leo throughout the month, and he is only visible in the mornings. He rises on the 8th at 3h. 29m. a.m., and on the 28th at 2h. 23m.

Occultations of Stars by the Moon.—On the 15th, κ Piscium (5th magnitude) disappears at 10h. 40m. p.m., and reappears at 11h. 28m. p.m. On the 20th, ξ Arietis (4th magnitude) disappears at 7h. 16m. p.m., and reappears at 8h. 15m. p.m.

The variable star Algol reaches its least light in the evening on the 17th at 10h. 10m., and on the 20th at 6h. 59m. E. J. LOWE.

THE MICROSCOPIC OBSERVER. OCTOBER.

MUD.—Previous to the recurrence of the autumn rains is a favourable time for explorations of the *débris* of old water-courses, the half-dry bottoms of ponds and ditches, and the mud within tide-marks on the banks of rivers. Though it is impossible to suggest decisively what the microscopist may expect to find in any particular muddy deposit, certain classes of organisms are almost invariably present. Diatoms and minute *Algæ* are generally discoverable; and in some cases samples of mud will be found to be almost wholly composed of them. Wherever a green, red, or violet-coloured slime is seen to form a sort of varnish on a wet mud-bank, a portion of the mud should be obtained for analysis under the microscope. The mud on sea-shores in the vicinity of the embouchures of tidal rivers is always rich in microscopic organisms, and especially so in regard to *Diatomaceæ*. If wet mud is to be made the subject of observation, it should be placed in phials with a little of the water from an adjoining pool; then, on exposing the closed phial to the light, the majority of the best takings will quit the mud for the water, and be seen on the sides of the bottle, from whence they can be separated. In the mud of ponds a sanguineous hue often prevails, owing to the prevalence in it of *Tubifex rivulorum*, a filiform annelid of from 1·5 to 3·4 in length. These worms are transparent, and show the alimentary canal distinctly, as well as the cilia lining it, and its own peristalitic action. Indeed, for illustrating some of the fundamental phenomena of animal physiology, we know of few better examples than the

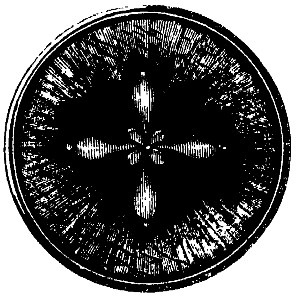


Tubifex. The species of *Stylonichia*—which belong to the *Oxytrichina*—are frequently met with in the *débris* of pools and the newly-formed mud of half-

dried ponds overhung with trees. When first determined under a low power, they have the appearance of monads, but under a power of 120 diameters present themselves as here depicted; ex-

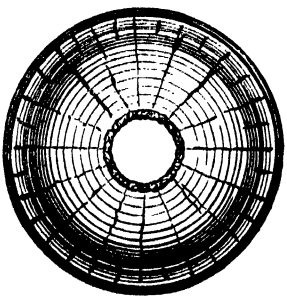
Stylonichia (kerona) pustulata.

cellent examples of the type of the old classification of *Polygastrica*. Among the Diatoms likely to be derived from muddy deposits, the *Naviculæ* are especially interesting, from the beauty of their forms and the symmetrical arrangements of their markings. Smith describes thirty-six British species, on which the authors of the "Micrographic Dictionary" remark,



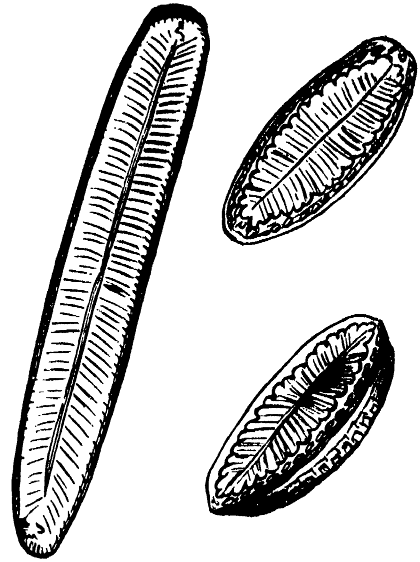
Nulacodiscus.

"they may all have been derived from a frustule of a *Schizonema* or *Colletonema*, which had escaped from its gelatinous envelope." Gathering in myriads,

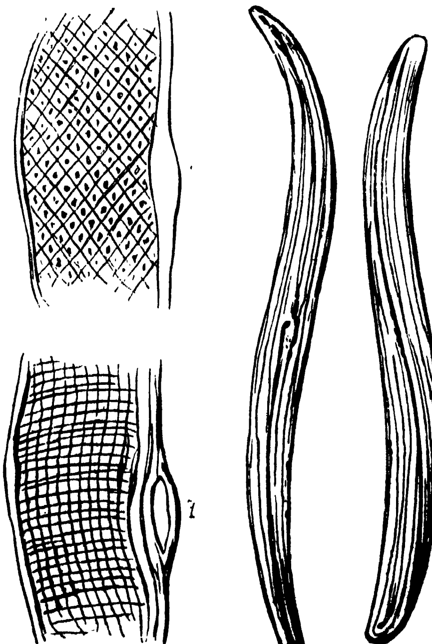


Arachnoidiscus.

layer upon layer, these minute organisms come at last to constitute the chief bulk of many of the sedimentary strata now in process of formation, just as in the celebrated Bilin slate Ehrenberg found that the forma-



Navicula hippocampi, Ehrenbergii.



1 2

1. Naviculæ hippocampi Ehrenbergii.—2. Hippocampus formosus.

tion consisted almost wholly of Diatomic fossils. Among the species determined by Ehrenberg, the founder of this department of microscopic research, the *Nulacodiscus*, with its reticulated surface, and star-like markings, has been proposed as the basis of a design for such works of art as trinkets. The *Arachnoidiscus*, with its exquisite tracery like a spider's web, is equally adapted to furnish a similar idea; indeed, there is no lack of patterns for our rising artists among the symmetrical forms of *Diatoms* and *Desmidiaceæ*.

Among the best of microscopic tests is the *Naviculæ hippocampi* of Ehrenberg. The several aspects of the frustules of this *Navicula* are roughly represented on the previous page.

These organic remains were found by M. Ehrenberg, in polishing slate tripoli, at Franzenbad, in Bohemia. The size of a single individual is about $\frac{1}{288}$ of a line, or the $\frac{1}{3456}$ part of an inch; twenty-three millions are contained in a square inch of Bilin slate, that is, about *forty-one thousand millions* in a cubic inch.

Mr. Noteworthy's Corner.

The Effects of Long-continued Heat, illustrative of geological phenomena, is the subject of a report by the Rev. W. Vernon Harcourt in the new volume of the "Reports of the British Association." Forty years ago La Place remarked that multiplied observations in deep mines, etc., proved the existence of a temperature in the interior of the earth increasing with its depth. Since that time increased attention has been devoted to the subject, and rapid progress has been made in applying physical and chemical science to elucidate geological problems. In 1833 the British Association intrusted a commission (consisting of Professor Sedgwick, Dr. Daubeny, Dr. Turner, and Mr. Harcourt) with the task of illustrating geological science by experiments. To the last fell the lot of conducting a portion of these experiments in two iron furnaces in Yorkshire, at Elsecar and Low Moor, the former being worked for a period of five, the latter for fifteen, years. The materials (provided partly by the British Association and partly by the Yorkshire Philosophical Society) consisted of a variety of minerals in various conditions, in one box, and organic remains, (both of animals and plants) in another box. The various substances in the boxes were separated in crucibles. The boxes were placed in the interior of the furnaces during their erection. At the end of fifteen years the Low Moor furnace was blown out. Nothing was left of the boxes but the iron straps with which they had been bound, in a state of oxidation. A few crucibles and parts of crucibles only survived the wreck of their contents; all the minerals, choice pieces, weighed powders, and compositions had disappeared; and all the exactness with which Professor Phillips had arranged them was lost labour. The deposits at Elsecar, at the end of five years, had not fared better. Two specimens, however, were worthy of notice. One exhibited the conversion of river-sand into sandstone, with a vacuity in its axis left by the volatilization of a plant. It was a stone of much tenacity, and came out a perfect cast. The other specimen was a translucent blue mineral, belonging to the class of *Lapis lazuli*. Outside the boxes under the bottom-stone in Low Moor furnace Mr. Harcourt had also placed other crucibles containing a bar of zinc, a block of tin, a pig of lead, and a plate of tile copper. The changes in them were very remarkable, showing the action on each other under the heating influence. They are represented in fine chromo-lithographic plates.

An Unintended Insect Trap.—The electric light, which is now used to illuminate the Place de Palais Royal, Paris, has lately been subject to remarkable changes in its brilliancy, arising from a very singular and unexpected cause. Every evening—and especially after a very warm day—clouds of insects collect around it, and each of them appears to be drawn irresistibly towards the bright points of burning carbon. But the instant they touch it they are broiled to death. The numbers that crowd to it, however, are so enormous that the light appears at times to be almost extinguished by burning insects, and every morning the bodies of these unfortunate suicides are found heaped up at the bottom of the lantern in thousands and tens of thousands. But, as an ingenious French *savant* has luckily discovered a new method of keeping insects out of lanterns, this cause of the discontinuance of the electric light will very soon be put an end to.

Memoranda.—M. Pelouze has presented a note to the French Academy on the spontaneous decomposition of gun-cotton in diffused light: the product of decomposition is a mixture of gummy matter and formic acid.—— The proximity of Electric Telegraph wires to powder magazines is proved to be dangerous, as suggested by Professor Faraday some years since. Professor Seguin, of Grenoble, has communicated to the Academy an account of a recent instance of lateral discharge during a storm, by which several trees were struck, and the wire itself was fused.——Father Secchi, of the Pontifical Observatory, has published, in the "Cosmos," a paper on the "Shooting Stars of August." He concludes that these phenomena are not meteorological, but cosmical, and considers the most rational explanation to be the admission that the sun is surrounded by a zone of small bodies which cuts the ecliptic at the point where the earth is situated on August 10. This theory of meteors is that long since adopted by English astronomers.—— Persons who use paraffine oil for illumination would do well to procure the Oilometer, sold by Cox, of Barbican, which determines the specific gravity of the oil on the same principle as the Lactometer. Paraffine of less specific gravity than 820° is dangerous.

Showing the Number of Whorls in the Garden Snail at Different Ages.

THE GARDEN SNAIL.

"Look with young wonder at the sliding snail,
Admire his eye-tipt horns and painted mail." DARWIN. *Botanic Garden.*

THE common snail is an animal so familiar to everybody, that it is a pity that his habits and peculiarities are not universally known. This unfortunate creature is proverbial for laziness. Dear old Dr. Johnson sarcastically calls him the "emblem of sloth." He is notori-

ous for his depredations on gardens. I have frequently heard country gentlemen growling out that "snails and *other insects* had destroyed their vegetables!" He is despised even by conchologists, on account of the plainness of his shell. Yet notwithstanding the general prejudice, it is quite possible that the history of such an animal may possess much that is interesting. Very probably the vulgar dislike of snails may have arisen from the circumstance that they were considered unclean among the Jews; but so were pigs, and we have now quite learned to like them. Besides I can adduce a passage from the Psalms (Psalm lviii. 8) to show that the vulgar, as usual, are wrong in the opinions they form: "As a snail melteth away, so let thine enemies pass away." This passage is interpreted by commentators to mean, that as the apprehension and dislike with which a snail is regarded by the ignorant and the unobservant departs, so shall the terrors of the enemy. I purpose, therefore, in the following pages, to give an account of the garden snail (*Helix hortensis*) from its birth; to describe his food, his manner of living, his physiology, and to detail, along with these, some curious observations and experiments of my own.

The appearance of the garden snail is familiar to everybody, and does not need particular description; but though he may not possess the divine colours or flowing grace of some of his more gifted brethren, he is still well worthy of the study of the zoologist. Snails are propagated from eggs. These eggs are laid about the end of July or the beginning of August. They are deposited in a sheltered and moist place—generally under a little clod of earth, or in some cool cavity. Their colour is white, and each egg is about the size of a grain of shot. Any person who takes pleasure in gardening must frequently have met with little bundles of globules, somewhat resembling bunches of grapes, which are the eggs of the snail. And here, about an inch below the surface of the ground, lie the seeds of life, safe from the action of the atmosphere, the breath of storms, the depredations of insects, and for the most part from the ravages of man. They remain in the same state, untouched and uninjured, until the middle of the following summer; and then, in that delightful season when all animal and vegetable creation are full of new life, and the world is clad in her gayest and grandest apparel, a wonderful change takes place in that dark, obscure grave, where the eggs have so long lain; little snails spring from them, protected with perfectly-formed shells about the tenth of an inch in diameter. I should mention that in the shell of the young snail there is only one convolution, whereas in that of the full grown there are four. As the young animal increases in size, his shell grows with his growth and strengthens with his strength. They require no instruction. Nature has endowed them with instincts to select what food is suitable to their wants. Immediately after their birth these young creatures leave their dreary cradle, and by separation dissolve for ever the ties of brotherhood. There seems to me to be something inexpressibly melancholy about the birth of snails, in the total absence of the care and affection of parents, in the want of comfort in their dark, damp, vault-like cradle, in their early struggles amid besetting dangers and difficulties, and finally in the heartless manner in which they bid each other an eternal farewell.

As soon as these snailets, if I may use the expression, are born, they set out in search of food: this consists of tender buds, young shoots, and fruit. The first summer of their existence is spent in joy and festivity. They do not attain full maturity until the following spring, and when summer, like a short melody, has passed by, they hide themselves in warm places, shut up the entrance of their shells with a thick kind of parchment cover, and fall asleep. Their winter

retreats are generally in mossy banks, bundles of dead leaves, or the crevices of walls. In these they repose securely until the storms and horrors of winter are passed, and in April, when the charming radiance of spring calls them into animation, they awake from their long sleep and emerge into active life. They are now full grown, and are so hungry, from their long winter fast, that they willingly eat almost anything green which comes in their way. The mouth of the snail, when viewed through the microscope, is found to be furnished with eight teeth of a kind of horny substance, similar to those of the leech. It possesses, likewise, a small cartilaginous tongue, covered with transverse striæ, and so disposed that by its movements it is well calculated to assist in propelling the food into the œsophagus.

About midsummer they lay their eggs. I may here observe that those who wish to get rid of these animals from their gardens should destroy them before they do this, as it is merely vindictive malignity to kill an individual snail, without the expectation of destroying his posterity. As there is no distinction of sex between snails, and as each individual is capable of laying eggs, and as each generally does lay about sixty eggs each year, it is manifest that they would naturally increase very rapidly. Indeed one snail would be the parent in three years of 200,000 snails. This is evident if we suppose that one lays sixty, and that each separate member of that sixty also lays sixty. Were it not for other animals, it is manifest that they would be worse than locusts; but, fortunately for us, they form the food of a great many birds. Supposing that one thrush eats fifteen young snails in a day, and supposing that during the summer months in which they can be found there are one hundred and twenty days, we shall find that eleven pairs of thrushes, in three years, including their young ones, will consume 1,350,000 snails. If, moreover, we calculate how many other animals prey upon them, and the chances to which the eggs are liable, we must be much surprised how many survive. It it said that snails are very injurious to gardens on account of their voracity, but I have my doubts about this. I am inclined to think that the chief injury is caused by small slugs, and that the snails, though few in number, yet being large and easily detected, come in for all the blame. They sleep the greater part of the day, and revel the greater part of the night. In this respect they might well be compared to the fashionable young men of the present day. Were it not for this the race would soon become extinct, as it would be entirely exterminated by birds of prey.

The organs of sight in a snail are peculiarly beautiful; they are situated in the extremities of the two superior tentacula or horns. The inferior pair, adapted more exclusively for the purpose of tactile impressions, are destitute of visual power. Both the upper and lower horns can be drawn into the head and completely inverted. It has been remarked that the sight of snails is peculiarly dull—and indeed this does seem to be the case to superficial observers; but if those people who were so ready to abuse the abused and to sneer at the unfortunate, had for a moment considered, they would probably have refrained from such inconsiderate statements. Snails can see perfectly well in the light that suits their eyes, and it is as fantastical to assert that they are nearly blind because they seem scarcely to distinguish objects clearly in the garish beams of day, as it would be to say that moths, or bats, or owls were dim sighted.

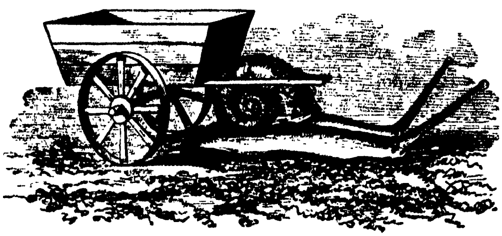
Land snails are possessed of no organs of hearing; although it is admitted that maritime mollusks are. I endeavoured in many ways to try if I could discover any sense of hearing; but all in vain. They are even insensible to music; and though it can charm a wild beast, it has no effect on a simple snail. I met with such a pretty story about the

effect of music on wild beasts, that I cannot help transcribing it here. Domitian, an old historian informs us, used to keep a company of elephants trained to dance to music. Upon one occasion, one of these animals failed to keep proper time; accordingly the keepers beat it severely; but one of them afterwards observed it to leave its dancing brethren, seek a secluded spot, and there practise his steps by himself. Again, Disraeli relates a story of spiders, in the Bastile, that used to descend on their silken threads to listen to a soldier playing on the flute. As long as he performed they listened in silent ecstasy, and as soon as he ceased they returned to their habitations.

Rhymer Jones says, that the sense of taste, judging from the structure of the tongue, must be extremely obtuse; but, if this were the case, I do not see why they should like some kind of food to other kinds. Thus, they prefer to eat pears or fruit to rose leaves, though they will eat rose leaves when they can get nothing better.

The sense of smell is very acute, although the exact locality of the organ has not been ascertained. An unpleasant odour causes them great annoyance, and when naphtha or turpentine is held near their heads they immediately retreat into their shells, exhibit decided signs of disgust, and even emit froth. These animals are also peculiarly sensible to touch.

Having thus glanced rapidly at the senses of snails, I shall now proceed to give an account of some experiments of my own. Their muscular power is very considerable. I found that a moderate-sized snail could pull, with apparent ease, a weight of five ounces. Observing this, I constructed a carriage for some which I kept. This, they drew admirably. The snails appeared in this to unusual advantage; and, I am willing to believe, enjoyed the novelty of the proceeding. Sometimes I used to make two or three drive tandem; but this was considerably more difficult. On the whole, this forms an amusing toy, and I should recommend it to the notice of the junior readers of the RECREATIVE SCIENCE. A simple noose passed over the shell of the snail yokes it to the carriage. Latreille gives a very curious account of a flea that performed a feat somewhat similar. He used to drag a silver cannon, on wheels, that was twenty-four times his own weight, which being charged with powder was fired without his appearing the least alarmed. Bradley asserts, that he has seen a stag-beetle carry a wand half a yard long and half an inch thick, and fly with it several yards.



In boyhood, my brothers and I used to keep snails for racing. These we used to feed with the greatest care. The race-ground was circular; in diameter about four feet, surrounded with a ring of green leaves. The racers were placed in the centre, and were restrained from running until the signal for the start was given; upon this they were immediately released, and then these phlegmatic creatures, stimulated into activity by the incentives of the gratification of their palates, and the hope of finding a comfortable resting-place among the green leaves, and perhaps warmed with the generous ardour of vertebrate animals, rushed madly on for victory. Whosoever reached the green leaves first was considered to have won. The snails should be painted different colours to distinguish them. Such a race possesses the interest of any other. If they did not run, we made use of a goad. We

found that if we pricked the part which was outside the shell, it naturally made the snail run into it, and accordignly before they commenced to race we generally bored a hole in their shells, through which, when pricked, they naturally sprang forward. I may add that the little racers were invariably kept on scanty rations for twenty-four hours before they ran, so that their appetites might urge them towards the green leaves.

The keeping of snails for such purposes naturally led me to observe their habits closely. Accordingly I had a glass globe of them on my dressing-table. I fed them about nine in the evening; and, as I gave them their meal pretty regularly, they at last learned the time, and as soon as they smelt their food, came crawling to it, with the same delight that chickens run to corn, or dogs to their dinner. It was very funny to see them with their long horns slowly crawling to their supper, and as it only remained in the glass for about an hour or a little more, those who were late got none. There are few animals more greedy than the garden snail. That servant of Dr. Franklin made a great mistake, who, when going on a tour of inspection with his master through the manufacturing districts of England, said, "Massa, in this country, everybody, everything must work—water work, wind work, fire work, smoke work, horse work, ass work, bullock work, dog work—only the pig no work; he only eat and sleep; de pig is the only gentleman in England." If this intelligent slave had been acquainted with natural history, he certainly would have considered the snail another gentleman. If doing no work and eating are the characteristics of a gentleman, then the garden snail is a thorough bred one. I do not see upon what pretext he can be deprived of such an honorary title. His food is composed of a variety of substances; he is very fond of young shoots, to obtain which he will often climb lofty trees. I recollect that I once measured the height to which one had ascended, and I found that it was fourteen yards; accordingly I became anxious to know how long he took to perform this, and I found, from experiment, that a snail can run ten inches in two minutes, that is, fifty feet in two hours. It is evident, then, that it is quite an easy journey to him to travel to the top of the tallest trees. Thus we see that a snail does not move so very slowly; besides, as Shakspeare says, we should consider that he "carries his house and his destiny with him."

The injury which these animals are said to cause the agriculturist or the horticulturist, forms one of the most prominent charges against them. This I think is greatly exaggerated, from the circumstance that if any snail does do so, he, from his magnitude, is immediately detected, whereas the slugs, the perpetrators of all the mischief, from their small size, entirely escape observation. A somewhat parallel case to this is, that the youthful part of the aristocracy are said, by some careless observers, to be more dissipated than the rest of the population. This has, however, merely arisen from this cause, that if there is a black sheep in that class, his misdemeanors are more notorious. However, if the gardener place a little lime round the roots of the plant, it will effectually preclude these animals. Moreover, that fruit which they have once nibbled should be left on the tree, as they will not commence any other, until they have consumed that. Some gardeners lay traps for them by placing cabbage leaves on the ground before night, which, in the morning, are generally filled with them. But, if snails do mischief, they also benefit man indirectly, as they help to support those songsters whose heavenly warblings give us such exquisite pleasure in spring. "Of the truth of this," says Markwick, "I have been an eye-witness, having seen a common thrush feeding on the shell-snail." The thrush breaks the shell upon a stone.

How he does this I am not aware.* I do not believe that he drops it from a height, as the eagle was said to have dropped a tortoise on the head of Æschylus and killed him. Snails are much recommended for consumptive patients. I am told that dyers make considerable use of them; and, last of all, they are eatable. I cooked some, and can conscientiously pronounce them to be excellent. The best way of dressing them is frying, but no doubt a good cook could convert them into a hundred delicious dishes. Before being eaten they should be kept some time. The "Gazette Medicale" mentions, that some peasants near Toulouse ate some snails freshly gathered in the garden, and all who ate thereof were poisoned. This occurred because the snails were full of some poisonous vegetables; but this is no objection to their excellence, and the reader will remember that Xenophon's army was poisoned by honey, the most simple of all luxuries. In some parts of the Continent snails are still eaten. Among the Romans they were thought to be great delicacies. Pliny mentions that they could fatten the *Helix pomatia,* a kind very little different from the *Helix hortensis,* so much that the shells used frequently to contain four quarts. Some scholars have admired the moderation which they thought the younger Pliny displayed in one of his letters, when he asks one of his friends to a supper of only three snails. He reminds me of that man who said he only ate one slice of bread for his breakfast, but upon examination it was found that this one slice consisted of half a loaf. It is rather an advantage, I think, that the garden snail is smaller than the esculent snail, as it is probably more delicate; small chickens and small oysters are considered more delicious than large ones. Persons who eat oysters alive need never object to cooked snails.

* The process may often be witnessed in a garden. The bird carries the snail to a suitable stone, and there taps the shell till it breaks.—Ed.

The power which the garden snail possesses, in common with other testaceous mollusks, of repairing injuries, is extremely wonderful. If a piece of the shell be broken off or fractured, he can mend this by emitting a viscid juice, which in about three days hardens. Spallanzani cut off one of the horns of one of these animals. It began to bud in about twenty-five days, and continued to grow until it was equal to the other. He then cut off the entire head of another; after the operation the snail retired into his shell, where he remained in seclusion for about four or five months, at the end of which time it was found that a new head had grown. Parallel cases to this can be found among other animals. Messrs. Kirby and Spence state, that if the legs of a spider be amputated they will grow again in a few days. If the tentacula of a lobster or crab be torn off, new ones will supply the loss. Spallanzani removed the entire shell from a snail, and found that he died; I did the same, but was agreeably surprised to find that my patient lived. I kept him for about three weeks, when, having forgot to shut the case in which he resided, he made his escape. I did not like to repeat this or to verify the former experiments, as they seemed to me to be wanton cruelty. Many naturalists seem to pay no regard to the sufferings of their victims, and silence all feelings of pity and commiseration by repeatedly asserting that the sensation of the lower animal creation is less acute than that of the higher. Our great poet expresses different sentiments—

"The poor beetle that we tread upon,
In corporal sufferance finds a pang as great
As when a giant dies."

A curious fact about snails is their retention of life. In the "Philosophical Transactions" there is an account of one that lived without food for fifteen years. This is stated on the most authentic evidence; at any rate, nothing is more certain than that they can live for four or five years without sustenance.

I may mention, also, that in the same work a beetle is described to have lived three years without any nourishment. When snails are thus deprived of food they fall asleep and retreat very far back into their shell; the mouth of this they cover with a thick, parchment-like secretion, technically called an operculum. Another remarkable instance of their retention of life is that of a *Helix hortensis*, at present in the collection of Mr. Pickering, which got entangled in a nut-shell when young, and, growing too large, had to endure the incubus to the end of his days.

Snails are born in the latter end of summer, are full grown at the end of the following winter, lay their eggs in the second summer of their existence, and spend the remainder of their days in revelry and dissipation.

"Go, child of pleasure, range the fields,
Taste all the joys that life can give;
Partake what bounteous summer yields,
And live while yet 'tis thine to live."

Few of these animals live more than two years, and their last season of enjoyment is doubtless tinctured by dark forebodings and gloomy anticipations of the future. And now joy-winged summer floats by; the days shorten; the golden fruits of autumn depart, and her enamelled flowers fade; ruder winds blow, and at last, beneath the influences of the increasing cold, the withered leaves fall circling to the ground. The snail forsakes the haunts of his youthful enjoyments, and retires to his long home. How miserable are his prospects now, compared with the splendid and enviable pleasures of his past existence? Might we not moralize from the state of a snail at this period of his life, and point out how utterly and hopelessly wretched old age would be, were it not cheered and illumed by the hope of a bright and a glorious immortality?

The hybernation of a snail takes place in the following manner. Even at this sorrowful time animal life still urges him to escape the frosts of winter; and, accordingly, having selected a suitable spot, with his muscular foot, and by turning round on his back, he excavates a hole about the size of himself; a thick, gluey fluid is then emitted, which gradually hardens and forms a plastering all round; a roof is made of the same substance and dried leaves. In this snug retreat he falls asleep, and if the winter be peculiarly mild he may survive; but the quantities of empty shells which are to be found in the places where they retire tells too sad a tale. They frequently select ivied walls for their last retreat, where the dark and gloomy emblem of eternity, when swayed by the breath of a frosty night, sighs mournfully over them their last requiem. They probably die without pain or suffering, as animals generally do which are frozen to death. I mentioned before that they usually live only two years; but in confinement, when they are not influenced by the inclemencies of climate, they frequently remain alive for five or six years.

It is not a little remarkable that that which during life had served as the house of the snail, becomes after death his coffin and his monument. This small and delicate structure endures the revolution of thousands of years, and our museums are stored with the shells of many that lived long before man. Perhaps, when we shall have perished, and man shall have passed away from the earth, and his name shall have become as unknown to a succeeding race as that of the antediluvians is to us, some of those very shells which we now arrogantly despise, surviving the lapse of centuries and uninjured by the inclemencies of climate, may become objects of speculation, wonder, and admiration to a different race of reasoning beings.

Such is a brief outline of the short and simple annals of the snail. In these there is little to attract, though, perhaps, much to instruct. In these there is no poesy; there is

none of that romantic diversity and striking incident which is to be found in the chronicles of wasps and ants, or with which natural historians love to crowd their pages. This animal, by reason of the immediate gratification of its appetites and its desires, is never induced to attempt anything memorable; its days, accordingly, are passed in sleepy indolence. In character it is harmless and inoffensive, incapable of feeling affection for man or towards its own species. Hoping that these few lines may turn the attention of some of my readers to a patient and diligent observation in this branch of natural history, and reminding them that each single new fact is of vast importance in a science entirely dependent on experience, I willingly conclude.

RICHARD L. EDGEWORTH.

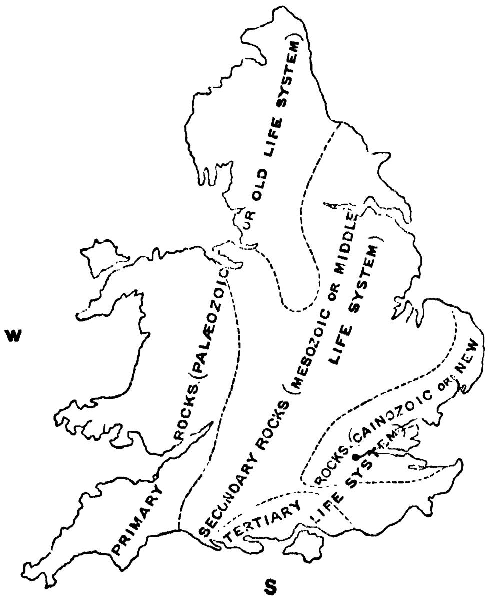
Edgeworthstown.

NATURALISTS' FIELD-CLUBS: WHAT THEY DO, AND HOW THEY DO IT.

BREAKFAST-TABLE companion, whom I find egg-eating in the "best room" of this clean country inn, whatever you may be doing here, fishing the trout stream, or getting up Æschylus, come with us to-day. I, a quiet member of the Oldshire Naturalists' Field-club, desire your company. This is a meeting-day, we assemble here in an hour, and at the close of the day return here to dine. If your notions are Waltonian, so much the better, for you will see that other occasions for quiet contemplation exist, and though the fishes we take cannot be enjoyed by the bodily appetite, they will strengthen and refresh the mind. If, as a rigid classicist, you are a reverent disciple of the old learning, there is no notion, worthy of keeping, that you need abandon. You may retain your exalted respect for Xenophon and Xenocrates, and yet be a believer in what Nature can tell you; she will throw a light, if you care that it shall be so, upon what men of the olden wisdom taught, and it will glimmer upon the grains of truth which lie scattered through their writings. Indeed, even if you have adopted the Hindoo notion of the earth as a living, ever-growing creature, bearing us all upon its rocky shell, as a tortoise would bear up a nation of polyps, you may hold to it without charge of natural heresy. For they who figured the earth by this form of creature were aware that, in one sense, growth is a quality of the world; that, daily and hourly, the crust which covers up the burning heart of the monster is being thickened by the addition of atoms too small to be singly distinguished, yet great in their aggregated bulk. They saw, though it was through a dim and distorting medium, that the settled, quiescent mass of solidity beneath their feet, was the basement of a lofty reaching series of invisible yet restless agencies, working in winds and clouds and vapours; guided, as it were, by innumerable spirits, who were missioned to use those powers to the end of time in moulding anew and redecking the surface, in building fairy palaces thereon with the grosser atoms of their natures, and sometimes in levelling all they had built, and scattering far and wide the accumulations of a thousand years. Join us, then, without fear. The study of the earth will not injure your faith in matters of Eternal import, lessen your aptitude for book-reading, nor unfit you for the domestic or business duties of life; for, whether you are a builder of suspension bridges, or a dealer in leeches; a seller of pea-sticks, or a maker of pickles; you may, by becoming a British field-naturalist, usefully and pleasantly employ the leisure at your command.

To give you a safe entry into the wide fields of natural science, guide you through them, and endow your mind with all benefits there to be obtained, this great and important rule must be observed—Nature must be studied by method, and in the order of her works. Go down to the basement of this wonderful earth-structure, and study the past, that you may know the present. Borrow what illustrations you please from existing animals and plants, but begin with the study of the ancient earth, as revealed by that branch of natural inquiry which underlies all others, even as the objects it describes are buried beneath the bright clothing of the life-clad surface. Study on this wise, and an ample repayment awaits you. Neglect it, and your march into the vast field of exploration will be without order and unsteady, your awakened interest will be staggered without being usefully directed, and your mind bewildered by the number of objects without being instructed.

First, then, try to learn of the natural growth of the earth. No single illustration will show you this, but many combined will do it. One I will tell you of, as an example of the pervading unity of creative powers, and the marvellous consistency of natural results. See, in yonder bramble bush, one



DESCENDING ORDER OF THE SEDIMENT-FORMED ROCKS.

TERTIARY, CAINOZOIC, OR NEW LIFE SYSTEM.—Pleistocene; Pliocene; Miocene; Eocene.

SECONDARY, MESOZOIC, OR MIDDLE-LIFE SYSTEM.—Chalk; Greensand series; Wealden; Purbeck; Oolite; Lias; Triassic, or New Red Sandstone.

PRIMARY, PALÆOZOIC, OR OLD-LIFE SYSTEM.—Permian; Carboniferous; Devonian, or Old Red Sandstone; Upper Silurian; Lower Silurian; Cambrian.

thorn-clad arm pushed out into a pale green, weakly-prickled shoot; it is the cap and crown of a branch, the latest outflow of the life-giving sap. Beforetime, other sap was nourishment to the older part of the stem, once green like this, now hard and woody, dark coloured, bearing fruit no longer. In seasons to come a farther extension of the plant juices will carry still higher the increase of the stem, and the tender new shoots of to-day will be lost in the silent advance of that continuous change which renews, year by year, the life-bearing face of the earth. Of the past duration of that life, its changes, its excess at one time and place and diminution at another, and of the variable nature of the slowly acquired crusts which bear witness of the lapse of time, the ocean itself, greatest of all earth-makers, is the noblest similitude. As men seated upon a western shore look over the broad Atlantic, so gaze we upon the ocean of departed time; seeing not the rise of the distant wave, but knowing it has had its rise and beginning, and is coming to us with a message from afar. Fancy yourself thus seated, and call every wave that is travelling shorewards an age of geologic time. To a careless eye every in-coming wave seems alike in form, foam-capping, and unity of purpose; but not so to ours. A differing foam-crest rides upon each, marking some speciality of its existence, and these, faintly seen when afar off, and more clearly distinguished when near at hand, are to our ocean-bent eyes like to those characteristics which distinguish a geologic age—the culmination of a life kingdom or the outcropping of a great physical event.

Those far off waves, strong and mighty of purpose, which have set in for the shore, may be called Palæozoic, old-life waves; those midway between the horizon and where we are sitting we will know as Mesozoic, middle-life waves; and those which would roll up to our feet, did not a line of hidden rocks convulse and dash them into spray, may fitly be called Cainozoic, new-life waves. So the great ocean before us, limitless to our sight, is triply divided by our fancy into zones of distance, corresponding to the three great eras of time which make up the life of the earth. Completing the analogy in its general view, we have, in the few feet of placid tide-flow lying between the breaker line and our meditative selves, a likeness of the period since man's creation, an era short and quiet by comparison with what had gone before it, but one to which, by gentle, God-whispered teachings, the goodness and worth of all distant ages has been brought, even as the flowing waters bring shorewards the spoils of the farthest wave and lay them at our feet.

This is no fanciful view of the world's history. Indeed, were it possible to ascend in a balloon so high above the smoke of London that England, laid out as in a map, would lie before us, we should see this ideal ocean-view finding its parallel in the rock construction of the country. Looking north-westward, the most distant parts, those skirting our horizon, would be the hill country of Wales and Cumberland, composed of rocks oldest in time, and containing the first evidences of terrestrial life. In folds and flexures, corresponding in their greater solidity with the billows in-rolling with a mighty purpose, but losing themselves midway in our view, these ancient sea bottoms would stretch over a third part of our prospect. Then middle-age rocks, sea-laid upon the eastern flanks of the Silurian hills, intervene, and stretch in a belt of surface yet wider and of greater area. New-life rocks, offsprings of later seas, make shapely to our view the eastern parts of the island; and, lastly, the picture of sea and lake deposit which has built up our country, is finished by the downcoming of the furies of the north—of the great ice drift, which, like the breaker fringe of our sea view, sheltered and relaid much that had

gone before, and divides as a rampart the world before man's time from the fairer land given him for his enjoyment.

If you would learn, before entering upon the study of the earth's crust, somewhat of he physical construction of the globe itself, and the agencies which have influenced the present configurations of its surface, you will get a good insight by noticing what goes on in a drying apple; what shrinkages and contractions come to pass; for the large rind being more than sufficient for the contracted sphere, some parts will be drawn down, depressed into valleys; others bulged up, elevated into mountain ranges. And wherever any great portion of the crust sinks in an unbroken area, the parts bordering it will be pushed up into elevations and folds, a double-action principle which has many and clearly-to-be-seen parallels on the surface of the earth.

Many natural movements, apparently of small value, will aid your comprehension of such great questions as the distribution of water upon the earth's surface, and the configuration of the land into hill and dale. A sea margin or the bed of a dried-up lake will, if exposed to the action of the sun, shrink into unequal-sided pentagonal areas, bounded by cracks; for there is a tendency in earthly substances to assume, in cooling or drying, a polygonal form. The cracks bounding these areas have been shown to correspond with certain lines of deep water which surround islands, and thus we have an insight at once into the laws which have, in connection with the shrinkage of the cooling globe, governed the relations of land and water.

Three men in our Club are noted for their geological attainments. The first—we will call him Mr. A—takes the Palæozoic or old-life rocks for his study, thus linking himself, like his illustrious namesake, with the beginning of things. He will tell you of the richness and variety of knowledge contained in the pages he is reading, for this great division of earthly time extends far beyond the title-page of the rock volume. Indeed it includes not only the sea-laid sediment of the Cambrian, Silurian, and Devonian ages, but the buried forests of the coal era, and finds its natural ending in the close of the Permian age, whose faintly-glimmering sparks of life bear evidence to us of the dying out of a mighty and long-lived creation, and the incoming—now that the land, upraised and dried, was fitted to receive them—of plants to be a clothing of beauty, and animals of nobler kind to inhabit it.

A study so greatly extended through time requires different ways of application, suited to the requirements of the many lesser divisions into which, for convenience, the epoch is divided. Traces of animal or vegetable life in the bottom rocks (called Cambrian, because the largest exposure of them is in Wales) are few and obscure, and the rocks show but slight proof of having been sea sediment, even as, to appearance, little of child-life remains in the gray-haired man. But their poverty does not lead Mr. A to disregard them. On the contrary, he searches the more diligently, and knowing the value of the faintest flashes of life-light from those old shores, he cherishes slabs impressed with many odd-looking markings, stone surfaces on which some game of life has been played, for the trails of the performers, peaceful or combative, are left upon the face of the stone. Some he tells me were worm-burrows, usually arranged in pairs, so that Mr. Vermis Arenicolite, if troubled with an unwelcome visitor at his front door, could pop out at a side one. Also, making merry over his curious store, he calls my attention to the impress, all wrinkled and wriggly, of some creature, which is like unto what a fish would make in a soft mud bank if he tried to walk upon his tail! The Silurian limestones, which cover up in most places these all but fossilless rocks, differ from them in being, almost throughout their thickness of 20,000 feet,

crowded with life remains, chiefly crustacean shields, marine shells, and corals. The Devonian rocks, higher still, have in their fish fossils a yet more important tenantry; and upon these lie the coal measures, better cared for, but containing more that is not understood, than any of the preceding deposits. Consequently they have a high place in the regard of our old-life friend, and with Mr. Hull's "Coal Fields"* in his pocket, he often pays Coalbrooke Dale a visit, and the greater coal-basin of Southern Wales.

The South Staffordshire coal-field, with its hideously disrupted and uninviting surface, has a mighty attraction for him, and here Prof. Jukes' book is his special confidant; and sometimes he steers northward, to the greater coal-workings of Lancashire and Northumberland. Taking his best wits with him at all times, and getting what evidence he can to solve the great questions touching the growth of the plants which produced this wonderful fuel; whether they clothed a surface comparatively dry, though subject to frequent inundations; or grew from out a saline marsh; whether, in a word, the waters which fed and strengthened the great moisture-loving plants were salt or fresh. Evidence to decide this he collects from the relics of crab and shrimp-like creatures met with between the coal-layers, and from shells, usually of marine affinities, which form in some places beds a foot or more in thickness. Another and, practically speaking, still greater question awaits settlement. The coal-seams which dip beneath the sandstones and limestones of Middle England, are believed by many to be re-elevated on a line of uplift nearly corresponding in direction of upthrow with the longitude of London. If this is the case, it follows that the coal measures of Somersetshire lie within an attainable distance of our Middlesex surface. The truth or falsity of this rests upon purely physical evidence, but the shores of France, to which country, be it remembered, England was formerly united, show good proof of the northerly extension of that line of elevation which has, in the uplift of the Ardennes brought a coal-field of no mean value to the surface. Trace this line north-westward, and it passes beneath London.

Perhaps no plant-fossils equal in beauty those of the coal age. They are easily obtained, by splitting up with the cutting edge of your hammer the gray shaly rock lying above the coal, which in every case contains them in greater or less abundance. Thus Mr. A can as faithfully picture to his admiring friends the plant-life of the age, as if he had stumbled on a collection of photographs, made by a gnome of the period. He will speak, while doing so, upon the wonderful persistency of form maintained by the fern-tribe throughout the vast extent of their life-time. So that fern leaves and horse-tail stems of coal-forest age differ but slightly from those of the present day, for our branching bracken, and still more graceful lady-fern, have a nearly allied cousinhood deeply laid in the treasury of the earth. And though these plants are scientifically lower in station than those which delight us with their flowers, yet they have the heritage of an excellent grace, a still-abiding and most pleasant beauty, which at all times we are glad to acknowledge. And year after year, as the bracken grows up among the heather, or makes the undergrowth of shady woods, our thoughts turn backward to the time when ferns were kings of the plant-world. Distanced in the race for station, the crown has long since passed from them, but with no loss of native grace they now bend before gaily clothed trees and flowers, productions of a younger age. There is so much to be learnt from ferns, fossil and living, that I recommend you specially to study them. By comparing old forms with recent ones, you will see that the plant has not reached its present state by age-long elaborations and slowly-acquired gifts, but

* London, Stanford. 1861.

that the first fern whose remains are preserved to us was as complete in its development, and as perfect in its functions, as is the living plant in the hedge-row of to-day. The juices and vapours of the earth and air have been, through the ages which are past, moulded, at the will of the life-giving Creator, into many and differing shapes, into forms regulated by the condition of the great substance they spring from, into bodies best able to contribute to its healthy existence. But throughout all time, the least-worthy spark of life, if in a normal state, has the divine stamp of completeness and perfection.

The closing scenes of the old-life panorama which Mr. A exhibits, are those of the Permian age, which there is reason to believe are not notably distinct from the carboniferous. At the top of these rocks worthy Mr. B meets him, and takes up the history. Like his palæozoic friend, the least-clear pictures he can paint for us are those which depict his opening scenes, but he gives a different reason for his inability. Absence of organic life, animal or vegetable, so far as we yet know, is a safe excuse for the desolate appearance of the earth's surface, during the early morning of its history. And Mr. A reasonably pleads this lack, as he exhibits his views; but our new friend, who has taken up with the history, the lingering shadow of all that in plant-life could be called luxuriant and gorgeous, has no such excuse for his poorly-filled and almost colourless canvas. But when he tells us *why* his show is so meagre at its beginning, and the actors so few, we see the landscape which through paucity of material could not be painted. The waters in which the new red sandstone was deposited were not lifeless, neither was the land unclothed with plant-growth, but no natural power of conservation laid up in store, and buried beneath an ever-thickening film of mud-atoms, as did preceding agencies, fern-leaf and fish-bone, coral-reef and shell. So by atmospheric attack they perished, and have scarcely, in England, left a sign of their existence. But the area of his lesson-book is a large one, and the rocks of the age improve in fossil-wealth, as they rise in geologic order. The barren sandstones at the base of the Mesozoic age are exposed over thousands of square miles in the Midland Counties, and in those bordering Wales, and make up, to some extent, for their organic poverty by the interesting physical knowledge to be derived from their study.

The pebble beds, which alternate with the sandy grit rocks, are specially worthy of notice. Lack of lime prevented their compaction into conglomerates, like those of the Devonian age, so we find the plums of these puddings loosely bedded; carelessly, as it would seem, received by sandy dunes, which wanted the strength of cement to fix and imbed into their natures the pebble-offerings of the sea. The salt rocks lie at the top of these poverty-stricken deposits, and these are of high interest to him. Though he will have to take a trip into Iceland, methinks, ere the method of their formation will be clear to him; for there a branch of the great firm of Dame Nature and Co. are said to be working the original receipt, with a modern result not unlike the ancient one.

But if the opening views of Mr. B are barren and nearly lifeless, such cannot be said of the kingdoms which follow them. An accumulation of sea-laid sediment, so rich and varied, that nearly fifty distinguishable beds have been measured and described in the lowest part, called the lias, of the great Jurassic series of rocks, gives him plenty of studies. Above them, the oolite limestones, iron-bands, and shales rest; and then, in a great unbroken series of physical deposit, and with constantly occurring creations of life species, the Purbeck and wealden rocks, with overlying clays and sands, and the well-known, but in the wealth of its treasured-up fossils, exhaustless chalk, finish up the epoch.

At this point, Mr. C takes up his work, and will show us canvas after canvas, crowded

with his organic relics. In kind nearly approaching to living species—indeed, his later histories show the first appearance of those now existing—and in number and variety equalling those of any age, the triply divided tertiary, Cainozoic, or new-life system, is one always replete with interest. Specially so, when the deposits immediately preceding man's creation come under his view, and he finds, associated with bones of huge animals, elephants, giant deer, and huge oxen, rudely shaped war-weapons, with which the last-created and noblest tenant of earth slew the beasts. How these ancient men lived, and where, there is as yet nothing to show. That they lived before the downcoming of the northern ice-drift, in many respects the most stupendous event of geological history, is not clearly established; for it is not till the subsidence of those waters, and till the disturbed powers of earth and air returned to a peaceful level, that any sign of man's domestic history is presented for his study.

The work of Messrs. A, B, C, and our other men of letters, having such direct relation with the two great objects of geological inquiry, first, the nature of the materials of which the earth is made, and the order in which these materials are disposed with respect to each other; and, secondly, the remains of ancient life contained in the rocks—they adhere, as far as possible, to the following rules:—Rock-specimens should be broken off from large masses in their native place, or taken from those which have recently fallen. A rock of noteworthy character must be broken into the depth of six inches, so that pieces can be got which have not been exposed to the elements, the exterior or weathered surface of a rock affording no certain indication of its character. The mineral composition of a rock seldom being uniform throughout its whole extent, several specimens should be collected, and choice made, not of the most attractive, but of those which show any variation from the one first obtained, so that the history of its formation may be complete. Where rocks cannot be got at by reason of later accumulations of soil, gravel, or sand, beds of rivers or mountain-streams will afford the wished-for specimens, and give instructive sections, especially if their course happens to cross the direction of the strata. These sections should in all cases be sketched on the spot, taking care to distinguish between the loose materials found above the exposed rock-sand, silt, or pebbles, and the solid strata itself. Note, in every case where these gravel or sand-cappings exist, the height of them at the point of your section above any near-lying lowland deposit, for, if lying upon mountain-flanks or hill-summits, they will be more ancient than mud or sand-deposits left in the valleys below by land floods or river action. Before consigning any specimen to your collecting-basket, attach a small number to it (it is well to buy a few sheets of these, and have their backs well gummed, and made fit for use), entering a note of its discovery in your memorandum-book, with the same number attached. If you wish your discoveries to be valued, this must be done upon the spot; accuracy in detail being of the first importance. Should you, while searching, meet with a fossil or a mineral of uncommon occurrence, let your note-book contain a complete account of the geological circumstances under which you found it, state its position in the strata, and whether it occurs in plenty; taking care to note with it the character of the rock which contains it, its dip and strike, if constant in these, or interrupted by veins and fissures, and whether throughout its extent it is uniform in mineral character. A drawing of the physical features of the rock or cliff will be a useful and valuable accompaniment to the note.

The weapons of attack you will need are not of complex character or very numerous. You may affect dandyism in them if you choose, but I don't think you will be a gainer

by it. A *good* hammer is the most important weapon—strong, well-tempered, and not too heavy. Some difference of opinion exists as to the shape of hammer best adapted to geologic purposes. No one that I have seen equals the simple form figured by the late Dr. Fitton in his appendix to Captain King's "Survey of Australia." This has a steel head four inches long, and one and a quarter inch square in the middle, a square striking face, and a vertically-inclined cutting edge: the diameter of the orifice for the ashen handle should be one inch vertically, and seven-tenths of an inch across.

A hammer of this shape has been my working friend for many years, and I never had cause to wish for any other. A strong steel chisel in working connection with it supplies the place of a miner's pick. Adding to these simple tools a good stout fishing-basket, and plenty of brown paper to wrap the fishes in, any one may travel England through, and collect the fossil and mineral treasures of every rock.

Of the delights of such rambles I have the liveliest sense. The remembrance of many enjoyable days is present with me—days when we dined *al fresco* in the forest of Wyre, or in green glades westward of the hills of Malvern; or not usually with less pleasure, in the "club-room" of a village inn—although that arena of rustic festivity was generally on the basement and paved with brick, the floor of no upper chamber being strong enough to bear the gambols of adolescent agriculture after a club-feast. Recollections of these rambles, mostly taken in the counties bordering Wales—for these would seem to be the natural home of field-clubs, though they were born in the border counties of the north—will never leave me; and now that I am removed by distance from that most pleasant field, and can but rarely join my old companions, thoughts of past excursions are gratefully cherished.

Musing over them, I seem again to see Ludlow, with its backward grouping of limestone cliffs and wooded hills; Habberley Valley, sweetest of Worcestershire dells; the stalwart, wildly-shapen hills of Caer-Carodoc and Longmynd, and the fair county of Hereford, orchard dotted, and leagured round with hills, watchers and guardians of its peace. But do not suppose that the field-clubs, which are doing such good work in these counties, give undivided attention to geology. It is not so. Indeed, there is an over proportion of botanists among them, and the other natural sciences have their disciples. You may take your choice of a special department for study; but, if you wish to be thoroughly grounded in Nature's teachings, the plan I set before you is the one to be followed. Study what you like in connection with it; look for the lake-shells whose shelly houses have most pleasant lines of beauty; search the fat swamp-ground for fungi, which are everywhere making living pictures out of dead and rotting sticks; collect the *Jungermanniæ*—moss-like plants they are, of exceeding elegance, and not wild men of the woods; call insects to your nets, and water-polyps to your bottles, but don't lose sight of the one true, natural foundation for field-study. Perseverance in this will sharpen up your senses for the comprehension of matters which now are caves of mystery to you, and in every mental quality you will be a gainer. Let no difficulty discourage you, and remember this for your comfort—that you may become a geologist without knowing the names of tens of thousands of fossils, or being able to refer at a glance a brown filmy patch upon a sandstone surface to the creature which once owned it as skin. An ancient wisehead, for whose sayings I have the most profound respect, has these words of encouragement for those who venture into the wide ocean of knowledge—"Let not thy smallness retard thee; if thou art not a cedar to help towards a palace, or liquid gold to restore a

prince, yet canst thou be a shrub to shelter a lamb or feed a bird; a plantain to ease a child's smart, or a grass to cure a sick dog." Be consoled then: and know, that in learning little, you are, if you learn that little well, extending the limits of the kingly domain of geologic science, whose fruits are daily offered for the regalement of honest hearts and teachable spirits. But do not repine because all who enter the temple are not chosen priests of its mysteries. Are not those who wait there, who trim the lamps and keep the sacred fire alight "all honourable men?"

Geological Society. GEORGE E. ROBERTS.

ON THE FORMS CONTAINED WITHIN THE CUBE.

IN the first volume of RECREATIVE SCIENCE, at page 271, will be found a paper descriptive of the anatomy of a cube, in which its external form, its edges, angles, solid angles, lines, and axes are considered, and a description given of some of the more remarkable sections that can be obtained by cutting it in various directions, and through a varying number of surfaces.

In the present paper it is proposed to treat of the beautiful solid forms that are contained within the cube; for as the unhewn block of marble encloses and conceals the most exquisite statues, requiring but the skill of the sculptor to cut away the superfluous and concealing exterior, in like manner does the cube contain an infinite series of the most interesting geometrical forms, requiring but

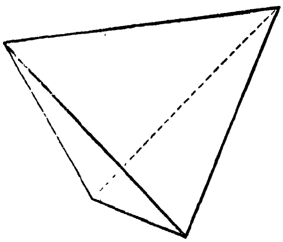


FIG. 1.

the knowledge of the geometrician to demonstrate their existence, and to cause them to develop themselves either to his mental or his bodily vision.

One of the most simple forms contained in the cube is that delineated in the annexed Fig. 1, which is known as the tetrahedron. It is the most simple of the geometrical solids, being bounded by four equilateral triangular faces, having only six edges which are equal, and four solid angles. Its position in the cube is shown in Fig. 2, and it will

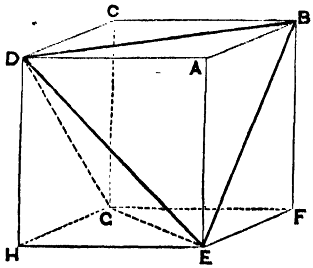


FIG. 2.

be observed that the edges of the tetrahedron correspond with the diagonal lines on the faces of the cube, and its solid angles with four of those of the cube. On reference, however, to Fig. 3, in which all the diagonal lines on the faces of the cube are shown, it will be evident, on careful inspection, that not only can the contained tetrahedron delineated in Fig. 2 be traced, but that there is a second in the opposite direction, every line of which crosses at right angles the corresponding line of the first. The three remarkable axes, which are contained within

the cube, and pass, as shown by the dark lines (Fig. 3), from the centre of each face to the centre of the opposite, are also contained in

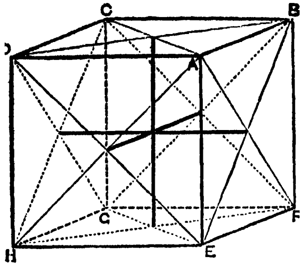


Fig. 3.

the tetrahedron, but in this solid they connect the centres of the opposite edges.

If the student wishes to prove physically the existence of the tetrahedron in the cube, nothing is more easy. Take a cube cut out of any soft solid, as a turnip or a block of soap; draw the diagonal lines represented in Fig. 2, and then cut away equally the four solid angles A, C, H and F, as represented in Fig. 4, continuing to do so until of the

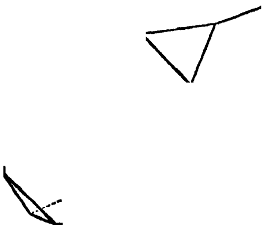
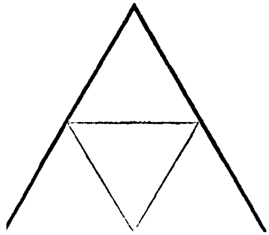


Fig. 4.

faces of the cube nothing remains but the diagonal lines, which will then form the edges of the tetrahedron.

To form a cardboard tetrahedron in the same manner as it was recommended to form the cube, an equilateral triangle should be cut out as shown in Fig. 5; each edge should then be bisected or equally divided, and the light inner lines should be drawn and half cut through the thickness of the cardboard. By so doing, the large equilateral triangle will be divided into four



smaller ones; and by folding these together a tetrahedron is formed more or less perfect, according to the degree of exactness with with which the envelope is drawn and cut out.

The tetrahedron is a very pretty solid of a quaint and unfamiliar shape; one involuntarily turns it over and over, and seems to be puzzled with its extreme simplicity and its distinctness from any familiar form; it is not, however, applicable to any practical use, and it may be that the mere fact of its

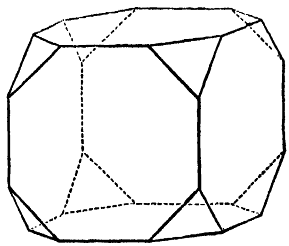


Fig. 6.

not being of common occurrence is the one which renders it more interesting than many other geometrical solids which are better known.

The tetrahedron is one of the five regular solids or Platonic bodies, inasmuch as its faces, edges, angles, and solid angles are all equal and similar.

If instead of cutting away only four of

the solid angles of the cube, the whole of them are equally removed by successive sections, as shown in progress in Fig. 6, until the original faces of the cube are entirely obliterated, a new form is next disclosed, having a face corresponding to each of the solid angles of the cube that are cut away; it is consequently eight-sided, and is known as the regular octahedron.

The best mode of cutting it out of a block of soap or any soft solid, is to mark, in the first instance, the diagonal lines on the faces of the cube, as shown in Fig. 3, then to thrust in six pins where they cross each other so as to represent the position of the axes. These afford a guide to the regular cutting away of the solid angles, which must be continued until nothing but the octahedron (Fig. 7) remains.

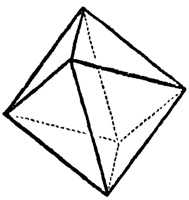


Fig. 7.

The position of the solid within the cube is shown in Fig. 8, where it will be observed

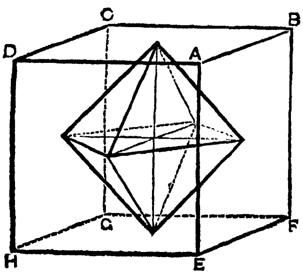


Fig. 8.

that the axes are common to both forms, and that consequently they connect the solid angles of the octahedron and the centre of the faces of the cube.

The octahedron is bounded by eight equal faces, each of which is an equilateral triangle; it has twelve equal edges, and six four-faced solid angles. It may also be regarded as consisting of two four-sided pyramids placed base to base.

To make a cardboard envelope for an octahedron of such a size as shall be contained in the cube, it is necessary, in the first instance, to describe two equilateral triangles placed as in Fig. 9, the sides of which are of the exact length of the diagonal lines on the faces of the cube; each of these two larger triangles, which are shown by the outer lines of Fig. 9, should be divided into four smaller ones, making eight in all. The outer dark lines are then to be completely cut through, the inner light ones to be only partially cut; when the whole will fold up into a perfectly regular octahedron, of such a size that it can be exactly contained in the cube.

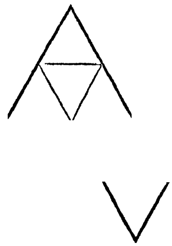


Fig. 9.

In order to save space, two scales have been employed in drawing our figures, the envelopes being half the size of those employed to represent solid forms.

The octahedron, like the two former solids, is one of the Platonic bodies or regular solids, as its faces, edges, angles, and solid angles, are all equal and similar. It is a very common form in Nature, many chemical substances crystallizing in this shape, and many minerals also occurring in it. Of the first, common alum is perhaps the most familiar example; of the latter, the well-known lead ore galena, or sulphuret of lead. The latter substance affords a very perfect and interesting example of what is termed cleavage in minerals. An octahedral crystal of lead ore will be found to break up readily, splitting in some directions with great ease, but the resulting forms will not be octahedrons but cubes. In the same manner cubical crystals of the common mineral fluor-spar can be readily made to produce either tetrahedrons

or octahedrons; thus showing the natural relation between all these forms.

If instead of cutting away the solid angles of the cube, the edges are removed so as to obliterate all its original faces, a very beautiful solid is obtained, termed the rhombic dodecahedron. It is a solid bounded by twelve equal and similar faces, termed rhombs, which are characterized by having four equal sides, with two acute and two obtuse angles; it has twenty-four equal edges, and fourteen solid angles, six being four-faced, and formed by the meeting of the acute angles of the rhombs, and the remaining eight being three-faced and formed by the meeting of the obtuse angles of the faces. The position of the rhombic dodecahedron in the cube is shown in Fig. 11. It may be observed that the axes run from one four-faced solid angle to the opposite, consequently these angles correspond with the centres of the faces in the cube.

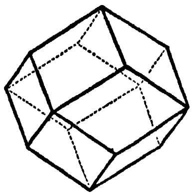


Fig. 10.

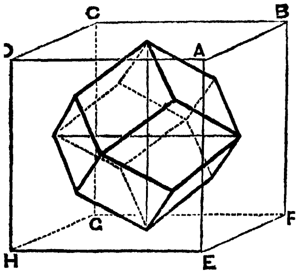


Fig. 11.

If it is wished to delineate this very elegant solid contained within the cube (as shown in Fig. 11), a cube should first be drawn in the equal measured or isometrical perspective described in the article in our previous volume. Then the series of axes passing from solid angle to solid angle, should be represented as shown in Fig. 12. Each axis should then be divided into four equal parts. The centre divisions of each will of course correspond, and be situated at the centre of the cube; the others should be marked by a point. It is then necessary to find the centre of each face of the cube by tracing the diagonal lines on its faces, and marking the points where they cross. When these have been found, all that is required is to draw four lines from the centre of each face to the points in the axes, and then the drawing of the rhombic dodecahedron, as shown in Fig. 11, is complete.

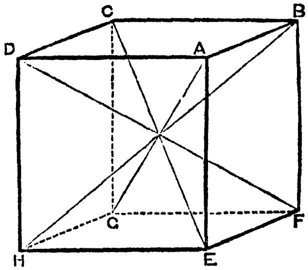


Fig. 12.

The delineation of the octahedron (Fig. 8) is still more simple; as, when the cube is represented in correct perspective, it is only necessary to find the centre of each face, when, by drawing lines from the centre of each, to that of each adjacent face, the octahedron is correctly represented as shown in Fig. 8. These four forms, the cube, tetrahedron, octahedron, and rhombic dodecahedron, have been selected with a view of showing a few of the beautiful relations that exist between different solids; but the subject is perfectly exhaustless. Many volumes, each as large as our yearly issue, would fail to describe and to delineate a tithe of the extraordinary combinations that exist.

W. B. Tegetmeier.

WAYSIDE WEEDS AND THEIR TEACHINGS.

HANDFUL VI.

"April smiles, and April tears,
Welcome them together."

WITH our Fifth Handful of "Wayside Weeds," and real veritable weeds most of them were, we also said adieu to the plants with netted veined leaves. As we have already remarked, in these our temperate zones, the netted leaf-veins characterize by far the largest proportion of our vegetable products, and, excluding the cereal and pasture grasses, by far the most important. They have accordingly engrossed the lion's share of these light sketches of Flora's kingdom; that they do not, however, monopolize all the beauty, our next Handful of their straight-veined relatives fully testifies. Nay, so much beauty do we find in the collection, that we expect our readers will demur at the word weeds at all. Weeds or flowers, whichever they be, they are probably more familiar to the town dweller than many more common flowrets; the most unmitigated townsman knows the snowdrop, the crocus, the hyacinth, the tulip, and the lily of the valley, those bright and cheerful blossoms which meet us everywhere in early spring; from the woodlands, where the first of the company pushes up its pure white bells through the withered leaves of the gone-by year, or the snow of the present one, to its bright-coloured sisters which shine forth in the plot of the "town garden" or of the suburban dwelling; which meet us in drawing-rooms on stand or mantelpiece, or giving brightness to every shop or market where vegetable produce is sold, proclaim that spring has come.

Take, as your first specimen of the second great division of flowering plants, those we have just named, only be careful that your tulips and hyacinths are single and not double blossoms, observing the same rule if you add a narcissus or a jonquil to the bouquet. But, leaving the garden, let us seek in the meadows for the bright purple orchis blossoms (Fig. 94), which every child

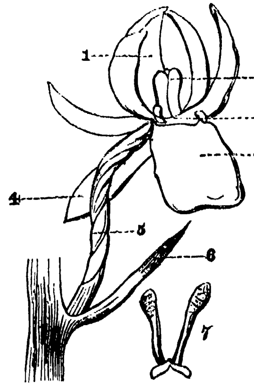


FIG. 94.—Blossom of Common Purple or Meadow Orchis: 1 1, pieces of the perianth; 2, pollen pouches; 3, stigma; 4, spur; 5, twisted ovary supporting blossom; 6, bract; 7, waxy pollen masses.

knows and gathers in early summer; these are really wayside weeds, and waterside weeds are these bright yellow iris blossoms, which few can be so unobservant as to pass without remark. Possibly all may not know the wild garlics, but they are pretty flowers, especially the commonest of them, the white-flowered, broad-leaved species. Its smell certainly does not warrant its introduction into the company we have already given you, so take or leave it as you like. Other plants you may find with straight-veined leaves, and it is well to examine all; and, last addition to the Handful, if you are gathering in midland or southern England, we give you the black bryony, which thrives so luxuriantly amidst the hedgerows, with

its very bright, shining, and characteristic heart-shaped leaves, mentioned, you may remember, in one of our late lessons, as being exceptional in their veinings. It is the British representative of the yams of warmer climates.

Without again referring to the leaves of our collected plants, we pass to the blossoms, and you will at once observe the peculiarity which all possess of having their parts in threes or sixes. We must here premise that in the present division of plants, the old familiar terms calyx and corolla give place to that of perianth, which is applied to the floral coverings, even although they appear external to, and distinct from one another, as in the snowdrop (Fig. 95). In

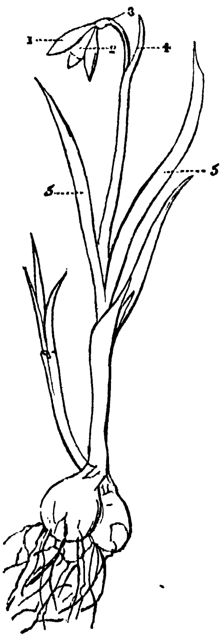


FIG. 95.—Common Snowdrop: 1, outer pieces of perianth; 2, inner pieces of perianth; 3, ovary; 4, bract; 5, straight-veined leaves.

the latter flower, observe, there are three external divisions of the perianth, and three within these; there are six stamens and three lobes to the stigma; lastly, the leaves are straight-veined, so that altogether the pretty little snowdrop is a perfectly orthodox and representative member of the monocotyledons, or one seed lobed plants. Not less so the tulip (Fig 96), with its six-pieced

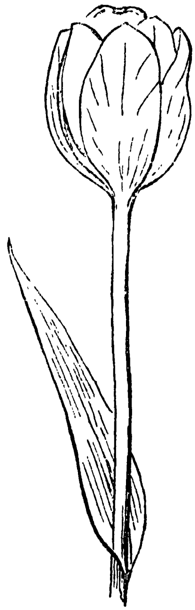


FIG. 96.—Blossom of Common Tulip, with its six perianth pieces and straight-veined leaves.

perianth, its six stamens (Fig. 97), and its three-lobed stigma (Fig. 98). Need we

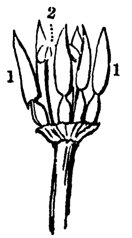


FIG. 97.—Essential reproductive organs of tulip: 1, stamens; 2, pistil.

FIG. 98.—Pistil of tulip with three-lobed stigma.

remind an uninitiated reader that if they look for wild tulips—they are rare to be met

with, and only in a few special places—they must not expect to find the bright colours of the cultivated flower, but a plain yellow blossom, which, however pretty in itself, has no claims to brilliant tinting. The lily of the valley—surely we need not try to describe the sweetest of woodland plants—has its six deep cuttings in its pure white bell blossoms, and the crocus, you will find, keeps up the family characters. Again, in the jonquil or narcissus we have this marked distinction between the internal and external perianth. The bright yellow, large, and handsome blossoms of the common iris or water-flag might well claim their place with any flowers however gay, but they may also claim to be really wayside plants, so common are they by river and pond side in the bonny month of June; they well carry out the ternate characters of the petaloid division of the monocotyledons. But this we have had so well exemplified in the members of this class, the snowdrop, tulip, crocus, etc., already adverted to, that we might have rested content with merely indicating the iris as a further example, had it not more to show us. You count the six divisions of the perianth, three alternately being longer than the other three, but within these again there are three other flower-like parts, what are they? Just raise one of them, for they are arched, and underneath you discover a stamen, and then it may probably occur to you, what really is the case, that these arched-looking petals, being in the centre of the flower, must be the styles; and truly they are petaloid or flower-like styles.

As a contrast and anomaly to the extreme regularity of the ternate blossoms and straight-veined plants of the petaloid monocotyledons, we should mention that singular-looking plant the Herb Paris (Fig. 99), which those who have the chance of exploring damp moist woods may find in blossom in the month of May. Its straight stem, its four, sometimes five ovate leaves arranged in a whorl or circle, from the centre of which springs the flower scape, the flower moreover not being composed of three or six pieces. All these characters combine to give us a very odd but interesting member of the present set of plants, and one which cannot be mistaken for any other member of the British Flora. Oddities, too, in their way, are the members of the next family, the bright and beautiful but very singular orchids. These plants have been so extensively and successfully culti-

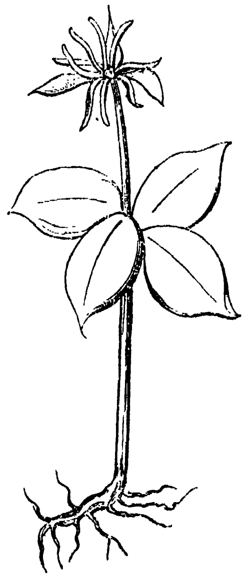


FIG. 99.—Herb Paris: with involucre of four whorled leaves or bracts.

vated of late years, that most of our readers must know some of the forms and appearances of foreign members of the tribe, even if they know not by sight the common "king-cups," or purple orchis of our meadows, the sweet-scented white butterfly orchis of our hill pastures, or some of the rarer and more singular forms, such as the bee and spider orchis, which abound in certain localities, more particularly in the south of England, and on chalky soils. Without digressing into many

interesting particulars, we must confine ourselves to get the essential characteristics of the order, from the common early purple orchis, the *Orchis mascula*, which purples many of our meadows in the month of May. We take one of its handsome spikes of flowers and pluck off a blossom (Fig. 94). You observe there is a bract at the base (Fig. 94, 4), and from the bract axil springs a twisted-looking stem or pedicel, this twisted support being the ovary or future seed-vessel of the plant, with its stigma spot (Fig. 94, 3) at its apex, surrounded by the six irregular pieces of the perianth. These also inclose two little pouches (Fig. 94, 2), which contain, not stamens, but little masses of waxy pollen (Fig. 94, 7). If you understand the above arrangement tolerably clearly, it will give you a clue to the construction of the beautiful and often grotesque blossoms of the orchis tribe.

All the plants which we have now placed in your hand belong to the petaloid division of the monocotyledons—a division which claims many of the brightest ornaments of our gardens; but yet all the petaloids, as we shall see in another Handful—we must make another—are not quite so bright in their clothing.

SPENCER THOMSON, M.D.

THE SPRAT AND OTHER PRODUCTS OF OUR WINTER FISHERY.

THROUGHOUT every quarter, nay, every month, of the rolling year, the well-stored shop of a leading London fishmonger is both an attractive and an instructive object of contemplation. Before such an exhibition we have seen many a passer-by linger for a brief space of time, and then reluctantly proceed on his way; and of these, we opine, not a few gave some account, to their home circle or friends, of the *curiosa naturæ* which arrested their attention. Longer, far longer than the ordinary passenger, have we stopped, and that "many a time and oft," to consider the specimens displayed before us, and seldom without carrying away in our mind something worthy of especial note.

Perhaps, however, the species exhibited in winter are more limited in number than those which cover the board in spring and summer—we miss the salmon, the trout, the turbot, the striped red mullet (*Mullus surmuletus*), the gray mullet (*Mugil capito*), piles of lobsters, crabs, and other crustaceans, which give promise of dainty fare. But then other species stand in their stead. The herring (autumnal and winter) vies in beauty with the mackerel. The haddock, the whiting, and the cod-fish, may take the place, not unworthily, of the turbot and mullet. The sole, good throughout every month (save the latter end of February and beginning of March, its spawning season), with gummy exudation on its surface, is ever acceptable; nor is the delicate Thames flounder (*Platessa flessus*) wanting. Pilchards are not often seen in the London market, and the great pilchard fishery is carried on in July and August; but not exclusively, for shoals sometimes appear in October and November. Here we might largely expatiate, but we are bound by space. One fish we needs must mention, namely, the sprat (*Clupea sprattus*), for to this little fish we would invite attention. Gone, as we have said, are the summer crustaceans; but then oysters in rough baskets and in wells (melting natives), may well represent them, nor are mussels and cockles unworthy the notice of the gourmet. And again, how often do we unexpectedly now and then meet with some strange fish, of singular aspect, which

puzzles the unlearned—even that rare creature the globe-fish (*Tetrodon Pennantii*, Yarrell), or the short sun-fish (*Orthagoriscus mola*).

With respect to the globe-fish or *Diodon*, the records of zoology give us only three examples of its capture on the coast of our island, and in each instance off Cornwall. The first was described by Pennant, the second by Donovan, and the third, taken at Mount's Bay, will be found noticed in the Proceedings of the Zoological Society for October, 1833. There is reason, however, to suspect that other examples have been taken from time to time, but which, having been treated with neglect by the unconcerned fishermen, have not found a place in the records of British ichthyology. The *Diodon* or globe-fish is remarkable for the power it possesses of inflating the spine-armed skin of the abdomen with air, till it resembles a balloon; in this state it floats on its back, and its spines being erected, it presents a well-armed front to any enemy which may venture to attack it. Cuvier and Yarrell both state that when thus floating it is at the mercy of the waves, and incapable of swimming; but this is an error, as was proved by Mr. Darwin ("Voyage of the Beagle"), whose interesting account is as follows:—"*Bahia, Brazil.* One day I was amused by watching the habits of a *Diodon*, which was caught swimming near the shore. This fish (he does not particularize the species) is well-known to possess the singular power of distending itself into a nearly spherical form. Having been taken out of the water for a short time, and then again immersed in it, a considerable quantity both of air and water was absorbed by the mouth, and perhaps likewise by the branchial apertures. This process is effected by two methods: the air is swallowed and is then forced into the cavity of the body, its return being prevented by a muscular contraction which is externally visible; but the water I observed entered in a stream through the mouth, which was wide open and motionless: the latter action must therefore depend on suction. The skin about the abdomen is much looser than that of the back; hence during the inflation the lower surface becomes far more distended than the upper; and the fish in consequence floats with its back downwards. Cuvier doubts whether the *Diodon* in this position is able to swim; but not only can it thus move forward in a straight line, but likewise it can turn round to either side. This latter movement is effected solely by the aid of the pectoral fins, the tail being collapsed and not used. From the body being buoyed up with so much air, the branchial openings (gill apertures) were out of the water; but a stream drawn in by the mouth constantly flowed through them. The fish having remained in this distended state for a short time, generally expelled the air and water with considerable force from the branchial apertures and mouth. It could emit at will a certain portion of the water; and it appears therefore probable that this fluid is taken in partly for the sake of regulating its specific gravity. This *Diodon* possessed several means of defence. It could give a severe bite, and could eject water from its mouth to some distance, at the same time it made a curious noise by the movement of its jaws. By the inflation of its body, the papillæ with which the skin is covered became erect and pointed. But the most curious circumstance was that it emitted from the skin of the abdomen, when handled, a most beautiful carmine red, and fibrous secretion, which stained ivory and paper in so permanent a manner, that the tint is retained with all its brightness to the present day. I am quite ignorant of the nature and use of this secretion."

The visitor to the British Museum may see numerous specimens of various species of *Diodon*, from the warmer latitudes, some of which are armed with most formidable spines, so that any large and voracious fish would pay a heavy penalty should he venture to

take one into his mouth. We may here observe that Pennant's Cornish specimen measured one foot seven inches in length, but others are far larger.

With respect to the short sun-fish, so called from its almost circular form, and brightly glistening surface, and which often attains a very large size, we have little to say. Specimens have been taken from John o' Groats to the Land's End—in the Firth of Forth—on the coast of Northumberland—off Yarmouth, at Salscombe—and on the Irish coast. In the fifth volume of "Loudon's Magazine of Natural History," page 315, there is a record of one that was taken at Plymouth. The specimen caught at Salcombe, according to Col. Montagu, weighed three hundred pounds. Mr. Yarrell saw a specimen in the London market, but he does not give us the locality of its capture. Several other instances of the visits to, and captures of this fish, on our coasts might here be enumerated; and as, according to Mr. Couch, it is migratory in its habits (the warmer seas being its true home), it is probably more common along our shores than is generally supposed. It appears to keep itself much to the bottom of the water, feeding principally on sea-weeds; but in calm weather it rises to the surface, and lies, apparently in a state of luxurious slumber, with its head above the surface of the water, and drifting with the current.

An allied species, the oblong sun-fish (*Orthagoriscus oblongus*, Cuvier), is much more rare in our seas than the preceding. It has been captured near Cornwall, and in the Bristol Channel. A specimen taken at Plymouth, in 1734, weighed five hundred pounds.

We must beg the reader to pardon this degression; but in speaking of the strange and curious fishes which occur at intervals in the London market, and are exhibited as a spectacle in the shop of the fishmonger, we could hardly avoid a glance at these rare and interesting species, heartily hoping that our reader may be so fortunate as to meet at least with one of them, and publish his observations in the pages of RECREATIVE SCIENCE.

Among the fishes of our surrounding waters, not the least important is the family of the herrings (*Clupeidæ, Abdominal Malacopterygeii**). The species consist of the following:—

The pilchard (*Clupea pilchardus*, Bloch, Cuvier, etc.); the common herring (*Clupea harengus*, Linn.); Leach's herring (*Clupea Leachii*, Yarrell); the sprat (*Clupea sprattus*, Linn.); the whitebait (*Clupea alba*, Yarrell); the Twaite shad (*Alosa finta*, Cuvier); the Allice shad (*Alosa communis*, Cuvier); and the anchovy (*Engraulis encrasicolus*, Fleming†).

Of these fishes (of which the whitebait and anchovy are so esteemed), the species to be seen, during the present season, on the board of the fishmonger, are the herring and the sprat. But the herring is not strictly a winter fish; it is captured wholesale throughout every month of the year, its spawning season being about the end of October or beginning of November, previously to which time it visits, with capricious selection, various portions of the coasts of the British Islands. Who can count the thousands that are taken! Some are sold fresh; but the great mass are cured by salt and smoke, and being properly dried, form an important article in the market. Some are more lightly or delicately cured than the rest, and under the name of Yarmouth bloaters are relished even by the

* *Malacopterygii*, fishes in which all the fin rays are soft, excepting sometimes the first ray of the dorsal or of the pectoral fins, which are spiny. *Abdominal*, or *Abdominales*, having the ventral fins suspended under the abdomen and far posterior to the line of the pectoral, and without attachment to the shoulder (or pectoral fin) bones.

† We may here just mention the sardine (*Clupea sardina*). It is not a British fish, but is taken in vast numbers in the Mediterranean, where the herring is not known.

epicure, either on the breakfast or supper table; in truth, a good bloater is a dainty. In the Isle of Man and elsewhere great numbers are pickled in brine, and secured in casks or barrels; and this is a practice in vogue on some parts of the Continent. We have tasted pickled herrings from Hamburg, but where prepared we could not precisely learn.

Pages would not suffice for the history of the herring. It is, however, to a smaller, but still much valued fish, that we wish at present to call attention. Let us at once introduce the sprat, the garvie of Scotland. The sprat (*le merlet, l'esprot*, or *haranguet* of the French), so abundant during the winter season in the fishmongers' shops of London, scarcely needs a formal description. We cannot, however, omit to mention that some of our older zoologists, following the erroneous idea of Ray and Willughby, have regarded the sprat as the young of the herring and also of the pilchard, or of one or the other. Amply has this mistake been rectified, and the true sprat is now acknowledged as a genuine species. It is true that the term sprat has been, and perhaps still is, applied by the Cornish fishermen to the young of the pilchard and of the herring. Hence, perhaps, the mistake of the two naturalists above mentioned; but it must be observed that the genuine sprat is very rare on the Cornish coast, so that the fishermen were unacquainted with it, and thus fell into an error of nomenclature. It is here worthy of remark, that on the eastern coast, where the pilchard is very seldom to be observed, this name (pilchard) is erroneously bestowed upon the young both of the shad and herring, or rather, perhaps, was; for our fishermen of the present day are far more discerning than they were a century ago, insomuch that an experienced man will recognize the species, even in the darkest night, by the series of distinct serrations along the acute edge of the abdomen. There are, besides, several minor points of distinction in the position of the fins, the decided fork of the tail, and the length of the under jaw, which exceeds the upper. So much for the claim of this little fish to its specific place in the family of *Clupeidæ*.

Though so abundant during the winter along certain portions of our coast-line, particularly the eastern and south-eastern, it does not appear that this oily little fish is by any means so abundant in the seas of the adjacent continent, nor yet of Ireland. It has been taken, it is true, on the coasts of some parts of Ireland—of Cork, Dublin, and Belfast, for instance; but not in the shoals which in Norfolk, Suffolk, Essex, and Kent so often glut the market to such a degree, that rejected cart-loads have been purchased at a cheap rate by the farmers, and spread over the fallows as manure.

Cuvier, speaking of "Le Merlet," takes no notice of any such abundance on the French coast; but, after describing it, and stating that it always remains far smaller than the herring, adds, "On en fait des salsaisons dans le nord;" that is, it is salted and "cured" in the north. He adds that Artédi and his successors have confounded the sprat (*l'esprot, ou merlet*) with the sardine; so that between British and Continental ichthyologists this little fish has had a troublesome time of it in the establishment of its own legitimacy. Linnæus includes the sprat among the fishes of his "Fauna Suecica," but we hear nothing of its vast abundance; nor do Professors Nilsson and Reinhardt, who include it among the fishes of Scandinavia, insist upon this point.

And yet, like the herring, the history of which has been so much distorted by Anderson, Pennant, and their followers, this fish is roving in its habits, and also migratory, tenanting the deep water, but not always returning at the appointed time in such astonishing shoals to the same spot. Its fishing season begins in November, when the

great herring season is over, but by no means closed. The same observation applies to the smelt (*Salmonidæ*), of which some of the finest we ever saw were purchased December 9, and are now while we write (November) common in the market, and in perfection. This delicate fish spawns in March and April, ascending the rivers in shoals for some time previously.

The great fishery for sprats is along the coasts of Kent, Essex, Suffolk, and Norfolk. They are also frequently taken in abundance off Dorsetshire, where Mr. Yarrell states that he has found them in June in full roe. In the *Taunton Courier*, January, 1832, we have the following notice:—"Upwards of a ton weight of sprats was sold in our market last Saturday. It is nearly fifty years since this useful fish visited the neighbouring coast, and they now appear in exhaustless shoals close in shore on the south coast of Devon."

Irregular as are the visits of the sprat to various parts of our shores, still the fish is not a great wanderer, its migration being from shallow into deep water, and there, of course, no fishery for it is carried on; but there it has numerous enemies. It is devoured by larger fish, and also by sea-birds, to which a shoal rising towards the surface is very attractive. Nor are these enemies—the larger fishes we mean—inactive during winter; but then ever-interfering man exerts his power, and shoals are captured. We learn from Mr. Yarrell that from four to five hundred boats are employed during the winter in this fishery. Thousands of tons are in some seasons taken, and sold (for manure) at sixpence and eightpence the bushel, the price depending on the supply and demand, to farmers, who distribute about forty bushels of sprats over an acre of land, and sometimes manure twenty acres at the cost of twenty shillings an acre. In the winter of 1829-30 sprats were particularly abundant; loads, containing from one thousand to fifteen hundred bushels, were sent up the Medway to Maidstone as manure for the hop-grounds.

We have seen sprats, more than once, extensively employed as manure in the portion of Essex adjacent to the embouchure of the Thames; and reflecting upon this fact, and upon the myriads consumed as food for man, and brought into our markets, to say nothing of the warfare everlastingly kept up by natural enemies, we have been filled with wonder that an almost total extermination of the species has not taken place; but no! be the destruction what it may, compensation is adequately made.

The roe of the sprat contains—we are speaking of a single female—nine or ten millions of eggs. We have tried to count them, but our efforts have been in vain, for the roe in all individuals is not of the same size, and a few grains weighed and counted do not give by multiplication more than an approximation to the sum total. With respect to the codfish, nine millions of eggs have been found in the roe of a single female; more than this number, great as it is, appears to us to be contained in the roe of a full-sized female sprat. Here, then, is provision against all contingencies, for be it observed that the roe is preyed upon by mollusks and the creeping things of the sea, for in this element the warfare of one creature against another is unintermitting and incessant day after day, month after month. Truce is never known.

We are informed by Dr. Parnell that sprats are found in the Firth of Forth throughout the whole year. During the summer months they are seen sporting about in large shoals, occupying a considerable extent of water, causing a ripple on the surface. At this season they are the principal food of many marine birds; but as the cold weather advances these fish desert the estuary, and ascend the firth to a considerable distance, selecting the spot where the fresh and salt waters mingle together, perhaps, for the sake

of warmth; for it is a well-known law in chemistry that when two fluids of different densities come in contact, that the temperature of the mixture is higher than that of either mingling fluid. Thus the temperature of the waters of an embouchure, like that of the Thames, is higher than that of the river itself or of the open sea.

The capture of sprats in winter, though it pays well, is no easy work. Some are caught by means of drift-nets made of fine twine, with very small meshes; but in general stow-boat nets, that is, large bag-nets, are usually employed. These nets at the mouth are about 22 feet wide and 36 high, and this mouth is kept square by means of beams and a heavy anchor. The net is so moored that the tidal shoals are carried into it, and when raised the machinery which keeps the mouth open closes, and thus secures the contents.

Sprats are sold in the shops for present consumption; nevertheless, thousands are cured and dried in the same manner as herrings, especially at Lowestoft and Yarmouth. They are sold by the dozen, or in bundles of one thousand each, tied up with twisted straw, and are frequently packed together in small barrels.

The sprat averages from five to six inches in length; very few exceed these dimensions. When fresh it ought to be clear and silvery, but the sanguine stain about the gills is no test of freshness. Pressure, heaps being piled upon heaps, will cause this appearance, and so will salt freely scattered over them.

With the shoals of sprats the fry of many other species are often caught in abundance, but these are useless except as manure.

W. C. L. Martin.

MARVELS OF POND LIFE.

How many marvels are discoverable in ponds it may take centuries of observation to determine, and of many of those marvels science may never attain to a full and clear perception of the laws which govern them, of the causes which produce them, of the results to which they lead in other and higher departments of Nature. Diatoms and desmids are inhabitants of ponds, and as Linnæus covered a patch of turf with his hand, and assured his pupils that they might devote a lifetime to the study of the few herbs comprised in a hand-breadth, so the pond philosopher may offer the contents of a single phial as worthy subjects for mental occupation during the remainder of a student's days. A little higher in the scale are the *Algæ*, of which our ponds furnish numerous species, and amongst the *Algæ* are *Protozoas*, *Rotifers*, and *Tardigrades*; the proteans, acrobats, and dancing bears of the microscopic panorama. Here we get among *Amœbas*, *Vorticellas*, *Euglenas*, *Oscillatoriæ*, *Hydras*, *Flossules*, *Melicertas*, and *Plumatellas*—a vast menagerie of diverse forms, which it is hard to name, and harder to classify, until certain elementary details have been boldly mastered. Books abound, ponderous books and unpretending books; some of the latter are scarcely worthy of the paper on which they are printed, and some of the former are so purely technical that none can use them to advantage until they have made great advances in the use of the microscope, and in systematic botany and zoology. But there are always two classes of readers for a really trustworthy elementary work—beginners, who have everything to learn, and adepts, who enjoy an occasional refreshing with reminiscences of early study, and who like to hear a master gossip on the amenities of the science which most delights him. For both these classes there is a book on Pond Life,* elementary in plan, anecdotal in style, beautiful in illustrative adornment, a book for the drawing-room table and for the microscopist intent on pleasant work. The author has arranged the results of his researches in the order of the months in which they were made, and, for the first time in the history of microscopic literature, we have our work arranged so as to occupy us with fresh subjects "all the year round." The organisms included in the recorded "takings" from the ponds of Hampstead, where Mr. Slack is wont to ruralize, include about sixty genera, very many of the species in which are described and figured, and of a certain few, which serve as physiological indices to the morphologies of their kindred, the structure and organization are fully treated with

* Marvels of Pond Life; or, a Year's Microscopic Recreations. By H. J. Slack, F.G.S. Groombridge and Sons.

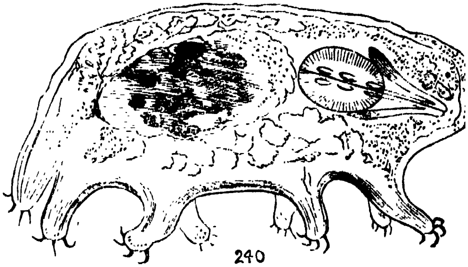
all the lights obtainable from contemporaneous research. On the first occurrence of a representative of an important class, the section to which it belongs is sketched in outline, that the student may thoroughly understand its relationships, and this leads the way to a full analysis of such physiological problems as arise out of the observation of cilia, nutrition, muscular movements, and sensational developments. Mr. Slack is not scared by difficulties; he ventures even to touch on the relative intelligence of his wriggling pets, and says enough about the shadows of intelligence low down in the scale of life to furnish matter for further observation and reflection. As to the pictures, they comprise thirty-five figures, many of them beautiful works of art, wonderfully life-like, and the details of structure are hit off with a rare touch of grace that would betray their origin if Mr. Slack had forgotten to say "the illustrations are taken from drawings made by the wife of the author from the actual objects." By text and pictures, then, Mr. and Mrs. Slack enter our charmed circle of microscopic friends, and many thanks to them for this delightful book. As it is needless to analyze in detail the contents of a work which makes no pretension to disturb accepted plans of classification, and which does not raise questions of the origin of things, one extract will suffice as an example of the method adopted by the author in recording his observations, and we select from the month of December the following notes on—

WATER-BEARS AND TRACHELIUS OVUM.

"When objects are not over abundant, as is apt to be the case in the cold months, it is well to fill a large vial with some water out of the aquarium or other large vessel, and watch what living specks may be moving about therein. These are readily examined with a pocket-lens, and with a little dexterity any promising creature can be fished out with a dipping-tube. It is also advisable to shake a mass of vegetation in a white basin, as the larger infusoria, etc., may be thrown down; and indeed this method (as recommended by Pritchard) is always convenient. Even so small a quantity of water as is contained in glass cell, appropriated to the continual examination of polyps or polyzoa, should be frequently hunted over with a low power, as in the course of days and weeks one race of small animals will disappear, and another take their place.

"Following these various methods in December, we obtained many specimens; but the most interesting was found by taking up small branches of the Anacharis with a pair of forceps, and putting them into a glass trough to see what inhabitants they might possess. One of these trials was rewarded by the appearance of a little puppy-shaped animal very busy pawing about with eight imperfect legs, but not making much progress with all his efforts. It was evident that we had obtained one of the *Tardigrada* (slow-steppers), or water-bears, and a very comical amusing little fellow he was. The figure was like that of a new-born puppy, or 'unlicked' bear cub; each of the eight legs was provided with four serviceable claws, there was no tail, and the blunt head was susceptible of considerable alteration of shape. He was grubbing about among some bits of decayed vegetation, and from the mass of green matter in his stomach, it was evident that he was not one of that painfully numerous class in England—the starving poor.

"A power of one hundred and five linear, obtained with a two-thirds object glass, and the second eyepiece, enabled all his motions and general structure to be exhibited, and showed that he possessed a sort



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Water-Bear.

of gizzard, whose details would require more magnification to bring out. Accordingly the dipping-tube was carefully held just over him, the finger removed, and luckily in went the little gentleman with the ascending current. He was cautiously transferred to Wenham's Compressorium, an apparatus by which the approach of two thin plates of glass can be regulated by the action of a string and a screw; and just enough pressure was employed to keep him from changing his place, although he was able to move his tiny limbs. Thus arranged, he was placed under a power of two hundred and forty linear, and illuminated by an achromatic condenser,* to make the fine structure of his gizzard as plain as possible. It was then seen that this curious organ contains several prominences or teeth, and is composed of muscular fibres radiating in every direction. From the front of the gizzard proceed two rods, which meet in a point, and are supposed to represent the maxillæ or jaws of insects, while between them is a tube or channel, through which the food is passed. The mouth is *suctorial*, and the two horny rods, with their central piece or pieces, are protrusile. They were frequently brought as far as the outer lips (if we may so call the margins of the mouth), but we did not witness an actual protrusion, except when the lips accompanied them, and formed a small round pouting orifice. The skin of the animal was tough and somewhat loose, and wrinkled during the con-

"* The achromatic condenser is a frame capable of supporting an object glass lower than that employed for vision, through which the light passes to the object. The appearances mentioned can be seen without it, though not so well.

tractions its proprietor made. The interior of the body exhibited an immense multitude of globular particles of various sizes in constant motion, but not moving in any vessels, or performing a distinct circulation.

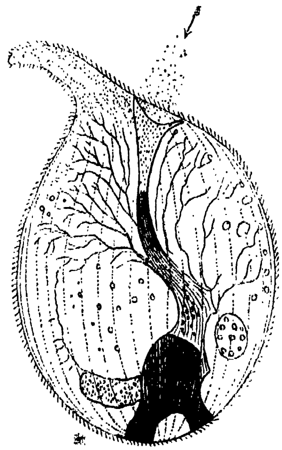
"My specimens had no visible eyes, and these organs are, according to Pritchard's book, 'variable and fugacious.' The same authority remarks, 'In most vital phenomena they very closely accord with the rotatoria; thus, like these, they can be revived after being put into hot water at 113° to 118°, but are destroyed by immersion in boiling water. They may be gradually heated to 216°, 252°, and even 261°. It is also by their capability of resuscitation after being dried, that they are able to sustain their vitality in such localities as the roofs of houses, where at one time they are subjected to great heat and excessive drought, and at another are immersed in water.'

"When vital processes are not stopped by excess of temperature, as is the case with the higher animals, the power of resisting heat without destruction depends upon the condition of the albumen. Soluble albumen, or, as it should be called, *Albuminate of Soda* (for a small quantity of that alkali is present and chemically united with it), after having been *thoroughly dried*, may be heated without loss of its solubility; although if the same temperature was applied before it was dry, that solubility would be destroyed, and it would no longer be a fit constituent of a living creature. As Dr. Carpenter observes, this fact is of much interest in explaining the tenacity of life in the Tardigrada.

"The movements of the water-bears, although slow, evince a decided purpose and ability to make all parts work together for a common object; and as might be expected from this fact, and also from the repetition of distinct, although not articulated limbs, they are provided with a nervous apparatus of considerable development, in the shape of a chain of a ganglia and a brain with connecting filaments. From these and other circumstances naturalists consider the Tardigrada to belong to the great family of *Spiders*, of which they are, physiologically speaking, *poor relations*. Like the spiders they cast their skin; and, although I was not fortunate enough to witness this operation—called, in the language of the learned, *ecdysis*, which means putting its clothes off—I found an empty hide, which, making allowance for the comparative size of the creatures, looked tough and strong as that of a rhinoceros, and showed that the stripping process extended to the tips of the claws. The 'Micrographic Dictionary' states that the Tardigrada lay but few eggs at a time, and these are 'usually deposited during the ecdysis, the exuviæ serving as a protection to them during the process of hatching.' Thus Mrs. Water-Bear makes a nursery out of her old skin, a device as ingenious as unexpected. The water-bears are said to be hermaphrodites, but this is doubtful.

"The *Plumatella repens*, described in a former chapter, was kept in a glass trough, to which some fresh water was added every few days, taken from a glass jar that had been standing many weeks with growing anacharis in it. One day a singular creature made its appearance in the trough; when magnified sixty diameters it resembled an oval bladder, with a sort of proboscis attached to it. At one part it was longitudinally constricted, and evidently possessed some branched and complicated internal vessels. The surface was ciliated, and the neck or proboscis acted as a rudder, and enabled the creature to execute rapid turns. It swam up and down, and round about, sometimes rotating on its axis, and at others keeping the same side uppermost, but did not exhibit the faintest sign of intelligence in its movements, except an occasional finger-like bend of the proboscis, upon which the cilia seemed thicker than upon the body. It was big enough to be observed as a moving white speck by the naked eye, when the vessel containing it was held to catch the light slantingly; but a power of one hundred and five was conveniently employed to enable its structure to be discerned. Under this power, when the animal was resting or moving slowly, a mouth was perceived on the left side of the proboscis, which was usually, though not always, curved to the right. The mouth was a round or oval orifice, and when illuminated by the parabola, its lips or margin looked thickened, and of a pale blue, and ciliated, while the rest of the body assumed a pinkish pearly tint.

"Below the mouth came a funnel-shaped tube or œsophagus, having some folds or plaits on its sides, and terminating in a broad digestive tube, distinct from the nucleus, and ramifying like a tree. The



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Trachelius ovum—slightly flattened.

constriction before mentioned, which was always seen in certain positions, although it varied *very considerably* in depth and width, drew up the integument towards the main trunk of the digestive tube, and thus the animal had a distinct ventral and dorsal side.

The branches of the tube stopped somewhat abruptly just before reaching the surface, and were often observed to end in small round vacuoles or vesicles.

"At the bottom of the bladder, opposite the mouth, in some specimens were large round cavities or cells, filled with smaller cells, or partially transparent granules. These varied in number from one to two or three, and were replaced in other specimens by masses that did not present the same regular form or rounded outline. In one instance an amorphous structure of this kind gradually divided itself, and seemed in the course of forming two cells, but the end of the process was unfortunately not seen. The annexed drawing will readily enable the animal to be recognized. It shows the mouth very plainly, and a current of small particles moving towards it. The œsophagus terminates in a digestive tube, like the trunk of a tree, from which numerous branches spring. This arrangement is probably analogous to that of the phlebenterous mollusks described by Quatrefages, in which the ramifications of the stomach answer the purpose of arteries, and convey the nutrient fluid to various parts of the body. It is also likely that they minister to the function of respiration.

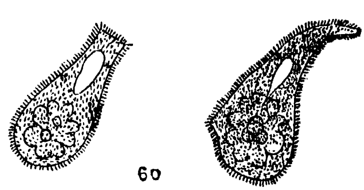
"The cilia on the surface, which are arranged in parallel lines, are best observed when the animal is slightly flattened in a live-box; but this process produces a considerable derangement in the relative position of the internal parts, and they can only be well seen when it is immersed in plenty of water, and is polite enough to stand still, and submit his digestive economy to a steady gaze. The only way to succeed in this undertaking is to have a large stock of patience as well as a convenient cell or trough. The table must be kept steady, and the prisoner watched from time to time, and at last he will be found ready for display.

"Pritchard says this animal, whose name is *Trachelius ovum*, is an inhabitant of stagnant bog water, and has been found encysted. My specimens could not be called plentiful, but for several weeks I could generally find two or three, by filling a four-ounce vial from the glass jar, and examining its contents with a pocket-lens. If none were present, another dip was made, and usually with success.

"One evening I caught a good specimen by means of the dipping-tube, and cautiously let it out, accompanied by a drop of water, on the glass floor of the live-box. A glance with the pocket-lens showed all was right, and the cover was very gently put on, but it had scarcely touched the creature when it became crumpled up and in confusion. On one or two former occasions I had been unfortunate enough to give my captives a squeeze too much, with the usual result of a rupture of their integuments and an escape of globules and fluids from the regions within. Now, however, there was no such rupture and no such escape, but instead of a smooth, comely surface, my Trachelius had lost all title to his specific designation, *ovum*, for instead of bearing any resemblance to an egg, it was more like an Irishman's hat after having a bit of a 'shindy' at Donnybrook Fair.

"I was greatly puzzled with this aspect of things, and still more so when my deranged specimen twirled and bumped about with considerable velocity, and in all directions. Presently a decided constriction appeared about half-way below the mouth and proboscis, and in a transverse direction. The ciliary motion became very violent in the lower half just below the constriction, while the proboscis worked hard to make its half go another way. For some minutes there was a tug of war, at length away went proboscis with his portion, still much crumpled by the fight, and left the other bit to roam at will, gradually smooth his puckers, and assume the appearance of a respectable well-to-do animalcule.

"Three hours after the 'fission' the proboscis half was not unlike the former self of the late 'entire,' but with diminished body and larger neck; while the remaining portion had assumed a flask form, and would not have been known by his



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Trachelius ovum, three hours after division.

dearest acquaintance. The portraits of the *dis-United States* were quickly taken, and, as bedtime had arrived, they were left to darkness and themselves. The next morning a change had come over the 'spirit of their dream.' Both were quiet, or sedately moving, and they were nearly alike. The proboscis fellow had increased and rounded his body, and diminished his nose; while Mr. Flask had grown round also, and evinced an intention of cultivating a proboscis himself. Twenty-seven hours after the separation, both had made considerable progress in arranging and developing their insides, which had been thrown into great confusion by the way in which the original animal had been wrenched in half, and in both a granular mass was forming opposite the mouth end. The proboscis portion, which may perhaps be termed the *mother*, was more advanced than her progeny, but both had a great deal to do if they meant to exhibit the original figure, and develop a set of bowels as elegantly branched. Whether they would have succeeded or not under happier circumstances I cannot tell, but unfortunately the Fate who carries the scissors cut short their days.

"In all other animalcules in which I had observed the process of multiplication by self-division, it seemed to go on smoothly, and with no discomfort to either the dividend or the quotient, and it may be that in the fission of the *Trachelius ovum* I witnessed what the doctors would call a bad case. Indeed it may have been prematurely brought on, and aggravated by the squeeze in the live-box. It is, however, probable, from the stronger texture and greater organic develop-

ment of this animalcule, that it does not divide so easily as the softer and simpler kinds.

"Frequent examination of this animalcule has created a strong doubt in my mind whether it is rightly placed in our 'systems.' My own impression is that it belongs to a much higher class, and is not a Trachelius at all."

METEOROLOGY OF NOVEMBER.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Mea elastic force of va our, or the pres- due to the water ained in the air.	Mean pressure of dry air, or the pressure due to the gases of the air.	Mean weight of in a cubic foot	Mean degre umi- dity 100 lete saturatior	ean quantity of water in a vertical colur of the atmosp ere.	W a cul air.
	Of an inch.	Inches.	Grs.		Inches.	Grs.
1848	0·247	29·531	2·9	0·85	3·4	545
1849	0·241	29·468	2·8	0·83	3·3	544
1850	0·275	29·414	3·2	0·88	3·8	541
1851	0·204	29·590	2·4	0·87	2·8	555
1852	0·276	29·201	3·2	0·89	3·8	537
1853	0·226	29·700	2·6	0·89	3·1	551
1854	0·230	29·430	2·7	0·88	3·2	546
1855	0·213	29·654	2·5	0·78	2·9	548
1856	0·216	29·674	2·5	0·87	3·0	554
1857	0·257	29·721	2·9	0·89	3·5	551
1858	0·214	29·545	2·5	0·87	3·0	552
1859	0·217	29·557	2·5	0·86	3·0	551
1860	0·201	29·501	2·3	0·78	2·8	550
Mean	0·232	29·538	2·7	0·86	3·2	548

The mean elastic force of vapour, *i. e.*, the pressure of the barometer due to the water contained in the air, is for November of the past thirteen years 0·232 of an inch; ranging between 0·201 of an inch in 1860, and 0·276 of an inch in 1852—a difference of 0·075 of an inch.

The mean pressure of dry air, or the pressure due to the gases of the atmosphere at the height of 174 feet above the mean sea-level, for November of the last thirteen years, is 29·538 inches; ranging between 29·201 inches in 1852, and 29·721 inches in 1857—a difference of 0·520 of an inch (or half an inch).

The mean weight of vapour in a cubic foot of air for November, during the last thirteen years, is 2·7 grains; ranging between 2·3 grains in 1860, and 3·2 grains in 1850 and 1852—a difference of 1 grain.

The mean degree of humidity (complete saturation being represented by 1·00) for November, during the last thirteen years, is 0·86°; ranging between 0·78° in 1855 and 1860, and 0·89° in 1852, 1853, and 1857—a difference of 0·11°.

The whole amount of water in a vertical column of the atmosphere for November during the past thirteen years is 3·2 inches; ranging between 2·8 inches in 1851 and 1860, and 3·8 inches in 1850 and 1852—a difference of 1 inch.

The mean weight of a cubic foot of air for November, during the past thirteen years, is 548 grains; ranging between 537 grains in 1852, and 555 grains in 1851—a difference of 18 grains. E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR NOVEMBER, 1861.

The Sun is in Scorpio until the 22nd, when he passes into Sagittarius. He rises in London on the 1st at 6h. 55m., on the 10th at 7h. 10m., on the 20th at 7h. 28m., and on the 30th at 7h. 44m.; setting in London on the 1st at 4h. 32m., on the 10th at 4h. 19m., on the 20th at 4h. 6m., and on the 30th at 3h. 54m. He is above the horizon in London on the 1st at 9h. 37m., and on the 30th at 8h. 10m.

He rises in Edinburgh on the 4th at 7h. 17m., and on the 18th at 7h. 46m., and on the 26th at 8h. 2m.; setting in Edinburgh on the 19th at 3h. 48m., and on the 27th at 3h. 31m.

He rises in Dublin on the 14th at 7h. 27m., and on the 28th at 7h. 52m.; setting in Dublin on the 16th at 3h. 59m., and on the 29th at 3h. 43m.

Day breaks in London on the 3rd at 5h. 3m., and on the 29th at 5h. 39m.

Twilight ends on the 3rd at 6h. 24m., and on the 29th at 5h. 57m.

Day breaks in Edinburgh on the 27th at 6h. 0m., and in Dublin on the 29th at 5h. 48m.

Decrease of day on the 10th, 7h. 28m.

The Sun is on the meridian in London on the 2nd at 11h. 43m. 42s. a.m., on the 17th at 11h. 45m. 11s., and on the 27th at 11h. 47m. 3s.

The equation of time is on the 2nd, 6m. 18s., on the 17th, 4m. 49s., and on the 27th, 3m. 7s. addative.

The Moon is new on the 2nd at 4h. 3m. p.m.

Full Moon on the 17th at 1h. 7m. p.m.

She is at her least distance from the earth on the 2nd, and at her greatest distance on the 16th.

Mercury is in the constellation of Scorpio at the beginning of the month, and in that of Libra at the close, unfavourably situated for observation. There is a transit of Mercury across the Sun on the 12th. (See separate account.) He rises on the 2nd at 8h. 52m. a.m., and on the 27th at 5h. 40m. a.m.; setting on the 2nd at 4h. 58m. p.m., and on the 27th at 3h. 18m. p.m. His diameter is on the 1st, 8¼″, on the 13th, 9½″, and on the 25th, 7″.

Venus is in Ophiuchus at the commencement, and in Sagittarius at the close of the month. The planet is unfavourably situated for observation; the phase resembling that of the Moon when ten days old. Her diameter is on the 1st 16½″, and on the 25th, 20″. She rises on the 2nd at 11h. 6m. a.m., and on the 27th at 11h. 23m. a.m.; setting on the 2nd at 6h. 18m. p.m., and on the 27th at 6h. 51m. p.m.

Mars is in the constellation of Virgo throughout the

month, and badly situated for observation. His diameter is $3\frac{1}{2}''$. He rises on the 2nd at 4h. 44m. a.m., and on the 27th at 4h. 39m. a.m.; setting on the 2nd at 3h. 52m. p.m., and on the 27th at 2h. 43m. p.m.

Jupiter is in Leo at the commencement of the month, and in Virgo at its close. His diameter is on the 1st, $31''$, and on the 25th, $32\frac{1}{2}''$. He rises on the 2nd at 2h. 11m. a.m., and on the 27th at 12h. 55m. a.m.; setting on the 2nd at 3h. 9m. p.m., and on the 27th at 1h. 37m. p.m.

Saturn remains on the borders of Leo and Virgo throughout the month. His ring disappears on the 23rd at 3 p.m. He rises on the 2nd at 2h. 4m. a.m., and on the 27th at 12h. 37m. a.m.; setting on the 2nd at 3h. 12m. p.m., and on the 27th at 1h. 37m. p.m.

Uranus is in Taurus throughout the month, and visible all night; rising on the 2nd at 5h. 59m. p.m., and on the 27th at 4h. 16m. p.m.; setting on the 2nd at 10h. 23m. a.m., and on the 27th at 8h. 40m. a.m.

Eclipses of Jupiter's Satellites.—On the 5th at 2h. 13m. a.m., 1st moon disappears. On the 6th, at 0h. 18m. a.m., 2nd moon disappears. On the 12th, at 4h. 7m. a.m., 1st moon disappears. On the 19th, at 6h. 0m. a.m., 1st moon disappears. On the 28th, at 2h. 21m. 57s. a.m., 1st moon disappears.

Occultations of Stars by the Moon.—On the 16th, ζ Arietis ($4\frac{1}{2}$ magnitude) disappears at 4h. 5m. a.m. On the 16th, τ^1 Arietis (5th magnitude) disappears at 7h. 6m. a.m. On the 21st, No. 56 Geminorum ($5\frac{1}{2}$ magnitude) disappears at 7h. 18m. p.m., and reappears at 8h. 7m. p.m.

The variable star Algol attains its least light in the evening, on the 6th at 11h. 51m., on the 9th at 8h. 40m., on the 12th at 5h. 29m., and on the 29th at 10h. 22m.

Stars on the Meridian.—On the 2nd α Arietis souths at 11h. 10m. 38s. p.m. On the 7th Aldebaran souths at 1h. 23m. 7s. a.m. On the 12th α Cygni souths at 5h. 9m. 29s. p.m. On the 16th Fomalhaut souths at 7h. 6m. 42s. p.m. On the 18th α Pegasi souths at 7h. 6m. 39s. p.m. On the 22nd α Arietis souths at 9h. 52m. 0s. p.m. On the 27th Aldebaran souths at 12h. 4m. 48s. a.m. On the 26th Pleiades souths at 11h. 15m. 53s. p.m.

Transit of Mercury.—Mercury passes over the Sun's disc on the morning of the 12th, under very unfavourable circumstances, the planet being on the Sun's disc when he rises, and the weather at this time of the year being usually cloudy in the early morning.

Ingress or entry of planet upon Sun, 5h. 15m. 48s. a.m.

Nearest approach of centres ($11'\ 1''$) 7h. 17m. 48s. a.m.

Egress or departure of planet from Sun, 9h. 18m. 44s. a.m.

Sun rises in London at 7h. 15m.

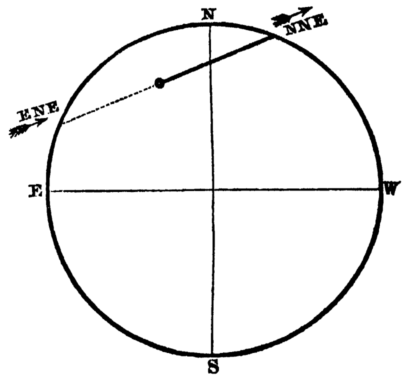
Diameter of Mercury $9\frac{1}{2}''$.

This transit is favourably situated for observation in Asia, Africa, and Australia.

Mercury enters the Sun's disc on the east side near his E.N.E. limb, and leaves the Sun at his N.N.E. limb.

The transits of Mercury always occur either in May or November. The first transit on record was predicted by Kepler to take place on the 7th of November, 1631, and this was observed at Paris by Gassendi. The next transit observed was on November 3rd, 1651, at Surat, in India, by Shakerley. The third transit, May 3rd, 1661, was seen at Dantzic by Hevelius, and in London by Huyghens and Mercator. The fourth, November 7, 1677, at St. Helena, by Halley. The reason why the transits of Mercury always happen in May or November is owing to the heliocentric position of its nodes. When the transit occurs in May, the planet is passing through the descending node of its orbit, and when in November the planet is passing through the ascending node.

Mercury, when on the body of the Sun, is seen as an intensely black circular spot. Various observers have noticed different appearances (perhaps merely optical illusions), such as a luminous spot near the



The above diagram represents the track of the planet across the Sun's disc, and the dotted portion being traversed before sunrise.

centre of the planet's disc, a distortion just before the contact of the limbs, etc.

Unfortunately the next transit, viz., on the morning of November 6th, 1868, will be unfavourably seen, so that it will be May 6th, 1878, before we can hope for a really good observation. After the transit of 1878, the remaining transits of this century, viz., 1881, 1891, and 1894, will be invisible.

METEORS.—The November epoch of falling stars about the 12th and 13th will be most favourable for observation after 2 and 3 a.m. (*i.e.*, after the moon has set). E. J. LOWE.

THE MICROSCOPIC OBSERVER. NOVEMBER.

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ON MOUNTING INSECTS ENTIRE FOR THE MICROSCOPE.—Until lately the slides supplied by dealers in

microscopic objects illustrated the structure of insects only by showing their limbs and organs in a detached condition, and so not only were several slides required to give a general knowledge of a single species, but no idea could be gathered from them of the arrangement of the several parts in the living insect. More recently slides have been obtainable containing entire insects, often of considerable size, as earwigs, beetles, etc., mounted as transparent objects. These beautiful preparations seldom fail to give pleasure to casual observers, and are especially useful to those who add the study of entomology to that of the microscope. The following method has been found successful in producing good examples of this style of mounting :—The insect is to be soaked for some days in a strong solution of potass (the liquor potassæ of the chemists), care being taken that the solution does not get upon the fingers, as it is a powerful solvent of the animal tissues, etc. The time required varies with the size and hardness of the insect, one of delicate texture may be sufficiently softened in two or three days, while a hard-cased beetle may take a month or more. A gallipot, furnished with a lid to keep out dust and restrain evaporation, will be found more convenient for this purpose than a bottle, from its larger opening, and the ease with which insects can be removed and examined. When the object is presumed to have been a sufficient time in pickle, it may be taken out by inserting the end of a glass slide under it, and flattened by gentle and very gradual pressure. The contents, softened and partially dissolved by the alkali, ought to escape without any obvious rupture of the integument. The pressure is best applied by laying another slide over the object, and if the latter offer much resistance, it may be returned to the solution for a few days more. When an insect has not been sufficiently soaked, the shelly covering is liable to be fractured under the pressure, especially the convex portions, such as the thorax, eyes, etc. On the other hand, too prolonged maceration will render the skin so tender that it will shrivel in drying; there is most risk of this with spiders and other soft-bodied creatures. Fortunately there is some latitude between these cases, and the appearance of the object in the potass will be some guide, as the colour is more or less discharged as the softening goes on; the metallic beetles become a testaceous brown colour, but most objects are overdone when the colourless stage is reached, and the object has, if mounted, a poor and unsatisfactory appearance. After flattening, the object is to be soaked some time in clean water, changed two or three times to extract the potass, or while the object is flattening, the ends of the slides may be immersed in water, which will rise between them, by capillary attraction, and the softened matter will be seen to flow away. The insect when cleansed may be floated on to another slide with distilled water, and the limbs, etc., displayed in a natural position by the setting needles and hair pencil, the superfluous water being then withdrawn by blotting-paper, the slide may be put aside to dry, carefully covered from the dust. When thoroughly dry, which it will be in a day or two, it is to be saturated with turpentine, which must penetrate into every member, or air-bubbles will result. If the object comes off the slide it may be immersed in the turpentine in some vessel, but if, as is most likely, it adheres to the glass, a thin glass cover is to be laid upon it, and a little turpentine dropped on the slide, when it will run under the cover, and surround the object, gradually displacing the air from all its cavities. As this may occupy some days, a drop of turpentine should be added from time to time to supply the loss from evaporation. When all air-bubbles have disappeared, which is best ascertained by the use of the microscope, or pocket-lens, the object is ready for the final mounting, which is done in the usual way, that is to say, a drop or two of Canada balsam is placed on the object, and warmed over a spirit-lamp—a candle will do if care is taken not to blacken the slide—and a thin glass cover pressed down upon it until cold, any bubbles detected before putting on the cover being removed with the point of a needle. Although it is much the most certain method to let the turpentine remove all air-bubbles before mounting in Canada balsam, yet if the bubbles are small, and the balsam is but little hardened by heating, they will generally disappear in a few days if the slide is kept in a warm place. The writer once mounted a large spider, with so many air-bubbles in the body and legs, that it was thought useless as an object; it was, however, left upon a warm mantelpiece, and as the bubbles were observed to diminish, it was allowed to remain there, they gradually grew smaller and disappeared, and in a month or six weeks not one remained. In this case the balsam must have been very liquid at first, or the bubbles would have been retained by its hardening. Very good objects may be made of the duplicate specimens which the store-boxes of any entomologist will furnish, recent subjects are in some respects preferable, but the card-mounted insects, intended for the cabinet, have the advantage of their limbs being ready set in the right position; the potass solution makes the oldest specimens as pliant as fresh ones. The orders *Coleoptera*, *Hemiptera*, and *Orthoptera* contain the best subjects, and every insect collector has specimens useless to him, but valuable to the microscopist; these, though they may be a few years old, if perfect, will show by this treatment a complexity of structure and adaptation to habits little dreamt of by many who exclaim against the buzzing or biting nuisance that disturbs their comfort and repose. Such specimens may be made important aids in education, and may impress the truth that the minutest objects are not one whit less wonderful than the largest, but all alike testify to the skill of the Creative Hand.—George Guyon, *Richmond, Surrey.*

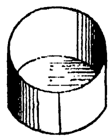
Mr. Noteworthy's Corner.

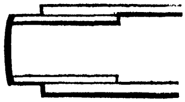
Telegraphic Alarum.—A large electro-magnet with a moveable armature, carrying a stem and a

hammer, which latter strikes on a bell by the direct force of magnetism. It is provided with a contact maker—a spring, the depression of which causes a current to circulate. The bobbins are 4 inches by 3 inches, and are filled with ten pounds of covered copper wire, No. 16 or No. 18. The core is of $\frac{3}{8}$ of an inch iron. The armature and appendages weigh $2\frac{1}{4}$ ounces. Electro-magnets thus made are active at distances up to seven miles, and the hammers strike loud blows. The battery is zinc-graphite, the solution is sulphuric acid, 1 by 8 or 10 of water. The plates, $7\frac{1}{2}$ in. by 3, are placed in quart pots of stone, the zinc standing in a gutta-percha slipper containing mercury. Batteries of this kind will do work for six months. Sets of from eight or ten to thirty or thirty-five cells are used, according to the distance.—F. H. S.

A Lunar Theory of the Weather.—A letter, signed S. M. Saxby, R.N., has been circulated through the daily press, the writer of which proclaims a distinct and intelligible theory of the weather. Instead of wandering into far space, as Mr. Sheppard does, and connecting the motions of Jupiter with the movements of the terrestrial atmosphere, Captain Saxby assigns to the moon the power of influencing the meteorological phenomena of the earth, at least during the continuance of certain relations between the two bodies. He says:—"Any new lunar theory to be appreciated must have been attested by observation; but this which I propose has been educed from consideration of large masses of observations: it is the offspring of indubitable facts, and partakes of their constitution, inasmuch as it has been under public, though limited, examination by eminently experienced practical men during twenty months, in which period I have issued and printed upwards of a hundred 'prognostics,' not one of which has failed. I have already proved the following, viz.: 1. The moon never crosses the earth's equator without there occurring at the same period a palpable and unmistakable disturbance in the weather. 2. That the moon never arrives at what may be called her stitial colure, or passes her point of greatest declination, without similar disturbance. 3. That, these disturbances being from electric causes, they are felt in both hemispheres, the regions of the trade winds excepted. 4. That the phases of the moon have in general no effect on the weather, but that when the period of new moon occurs at the time of her perigee, or at either of the periods mentioned in Nos. 1 and 2, disturbances there referred to are considerably augmented. 5. That the disturbances and changes of weather above mentioned are most probably towards high winds or lower temperature, and, when not particularly felt on the earth's surface, may at such periods be plainly traced, even during dead calms, in the hurrying scud and other atmospheric indications sufficient to warn those interested to be prepared for coming consequences. Now this is a public challenge. I am ready to defend it, or to acknowledge fairly and honourably any truths, if proved to be such, which may be brought in opposition hereto. If the above theory be true, I shall have had the pleasure of conferring a great benefit on my fellow-men, and upon posterity; if not, I claim the merit of having earnestly tried to do so. The nature of my prognostications up to Christmas will be seen by the following copy of printed papers, eagerly sought after by sailors, pilots, etc.; whom I have furnished to the extent of my means, for it is a great advantage to know the periods at which changes are probable. 'July 5 or 6, 12, 18 or 19, 25; August 2, 8 or 9, 15, 22, 29; September 5, 11, 18, 25 or 26; October 2 or 3, 8 or 9, 15, 23, 30; November 5 or 6, 11, 19, 26; December 2, 9, 16, 23, 30. N.B.—September 4 to 7, October 2 to 5, November 2 to 6, December 1 to 3, are likely to be periods of unusual disturbance. In conclusion, I beg to remark that one great value of my weather system is in its calling attention to periods of atmospheric disturbance not usually indicated by the barometer."

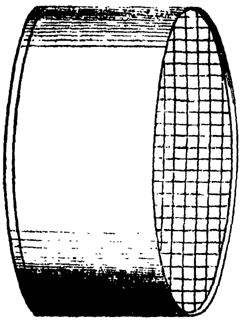
Home-made Microscope. — "A Country Subscriber" will find in the article, "My Microscope," that the centralization is provided for, first, by taking the centres of the pill-box, or pieces of card meant to fit the end of the tubes with the compasses; secondly, by letting all wrappers of card only *meet* at the edges, and not wrap over, which would evidently decentralize; thirdly, by letting the tubes which hold the eye, or object-glasses, be long enough and far enough in not to *give* thus, that is, let them have a *long inside purchase.*

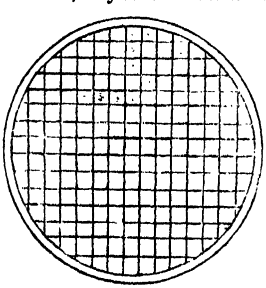




Hearing with Two Ears.—M. Purkynie has communicated to the Bohemian Society of Sciences some interesting experiments upon the perception of sound by the ear. Two india-rubber tubes formed at one end into a hearing trumpet were introduced, one into each ear, and two persons spoke at the same time into the two trumpets. Some time always elapsed before it was possible to distinguish the words on either side, or even on both sides at once. When the tubes had several branches so that more than two persons could speak at once, it was impossible to understand their words. When two tubes were united into one trumpet, the sound of the voice was heard always as if it existed inside the head, upon whatever side the person speaking was placed. By this means we might examine the relative sensibility of the two ears, for, when they differ, the sound appears to reside in the head nearer one ear than the other. M. Purkynie thinks that the illustration in question may be explained by the structure of the auditory conduit and of other parts of the organ of hearing. With two tubes communicating with the two ears, M. Purkynie could not succeed in associating two vowels so as to hear a diphthong. But by adapting to one ear a tube with two branches, each vowel associated easily with every other, and diphthongs were heard perfectly. In the same way two sounds, such as *s* and *a*, *f* and *a*, etc., might be confounded in syllables. Two musical sounds, when heard by the tube, produced a third tone by combination, which appeared to have its seat in the inside of the head.

The Rising and Setting of the Sun Physiologically Considered.—In the July number of "Recreative Science" there is an ably-written article upon the apparent distortion in the disc of the Sun which takes place at rising and setting, and the singular fortuitous experiment there recorded as made by the author and his artist friend is certainly *new*, and deserves to be recorded. The subject is an extremely difficult one, and is perhaps rendered by the writer in as popular a form as it is capable of, and it is not my intention to enter in the least into the vexed question of which explanation is the most probably correct, although certainly the fact of his unpremeditated experiment is a stubborn one, and cannot be put aside. I read the article with great interest, because it is a subject upon which I have very often mentally speculated, and intended (an intention never, however, carried out) to endeavour to solve the enigma, by actual proof. As I have neither time nor opportunity now, however, for this trial, it does not follow that I should not suggest the idea to others who may be able to make it. It is simple enough, or I would not suggest it. Take an ordinary chip-box, we will say of some two inches diameter, and removing the bottom, substitute in its stead a piece of coloured glass, either blue, red or green, blue would probably answer best, across which lines must be drawn, as in the accompanying figure, and these might be made with a glazier's diamond. Being provided with this simple apparatus, choose a fine day, and look at the rising sun through this instrument, and you will be able, by means of the small graduated squares, to count how many are occupied by the sun's disc, very much in the same way—the operation being, however, reversed—by which manufacturers test the fineness of cloth by the cloth microscope. Having thus ascertained the number of squares thus occupied, put by the glass until noon, and *then* repeat the same process, and again at sunset. This will furnish an infallible test as to the *apparent* size of the luminary, not touching the question of whether the effect is mental or visual. And the same thing might be tried with the moon also.—O. S. Round.





Rock-Oil and its Geological Relations have been investigated by Professor E. B. Andrews, of Marietta College, Ohio. There are two distinct geological formations in the West, from which petroleum or rock-oil may be obtained—the bituminous coal measures and the Portage and Chemuny groups (or Waverley sandstone). These sweep round in the form of a quadrant from north-western Pennsylvania into southern Ohio, and south into Kentucky. On these rocks are situated the famous oil regions of Pennsylvania and north-eastern Ohio. Those of western Virginia and southern Ohio, and a part of western Pennsylvania lie in the coal measures. Marietta, Ohio, may be regarded as the centre of these extensive oil-fields. Various theories exist with respect to the formation of this oil. One assumes that it is the product of subterraneous distillation of bituminous strata, at either high or low temperatures. Another theory presumes that the oil was produced at the time of the original bituminization of the vegetable or animal matter. To both these theories objections are made, which Professor Andrews duly considers in an article in the "American Journal of Science," illustrated by interesting diagrams. The oil-wells of Little Kanawaha have been unparalleled for the quantity of oil produced. Many of them when first bored poured out the oil in torrents, it being forced up by the pressure of gas. Hundreds of barrels were obtained from one well in a few hours. The oil is frequently quite free from water, and is passed directly from the well into barrels for shipment. The heavier oil, not profitable for distillation is valuable as affording a superior lubricant. The oil is evidently the accumulation of ages.

New Planets.—The one discovered by M. R. Luther, on August 13th last, has been named Niobe by the Congress of Astronomers assembled at Dresden. It is the 71st of the Planetoids, and is now in the constellation of Aquarius, and appears as a star of the 11th magnitude. M. Goldschmidt has announced to the French Academy of Sciences his rediscovery of the planet termed Pseudo-Daphne. On May 22, 1856, he discovered Daphne. On Sept. 9, 1857, he discovered a planet which he supposed to be Daphne, but which the calculations of M. Schubert proved to be another planet, since named Pseudo-Daphne. This latter, after having been long vainly sought for, was once more discovered by M. Goldschmidt on August 28th last. Its motions accord perfectly with the ephemeris of M. Luther, who has never ceased to seek after it.

Habits of the Hedgehog.—In Mr. W. C. L. Martin's letter to Mr. Noteworthy, he states, "that the hedgehog sucks the milk from cows is a vulgar error," etc., etc. Believing that it is the wish of your correspondents as well as yourself to elicit truth, I beg to assure you that instead of being a vulgar error it is a stubborn fact, of which my eldest son has been eyewitness. The hedgehog was very reluctant to be separated from the cow's teat, which was so inflamed that it was advisable to kill her.—Henry Turner, 56, *Woolmonger Street, Northampton.*

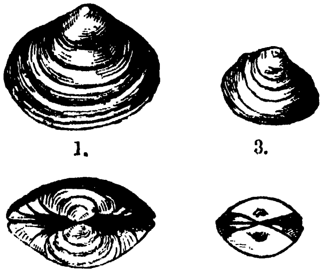
BRITISH BIVALVES AND GASTEROPODS.

JUST stooping under the bridge at Lenton, on the way from Nottingham to Mr. E. J. Lowe's Observatory at Beeston, a little shoal of every variety of land-shell washed down by the summer floods, the animals drowned, and the conchology perfect in its natural colour and enamelling, fills the collector's receptacle without the trouble, yet at the same time without the valuable experience afforded by tracing out these tiny British mollusca in their natural haunts. As such another bag of shells, however, is not everywhere to be had, I shall just give a glance through one brought me by the late Mr. John Froggatt, who resided upon the spot. It is a place endeared to literature by the former residence of William and Mary Howitt, in the large modern building near at hand known as the Priory. The few existing relics of the ancient priory of Lenton, indeed, founded by William Peverill (son of the Conqueror), lie shattered around—excepting possibly the sculptured fragment of a stone mullion and an old refectory housekey, at this moment grouped amongst the shells at my feet. The river Leen, which shortly falls into the Trent, and glides gently, in fact, through half the fat abbey lands of Notts, winds its way hither from Lord Byron's far-famed park of Newstead, bearing these rich little molluscs in its bosom. To the curious query of Mr. Thompson, of Weymouth, whether sheep eat snails? since the best thriving sheep are ever seen where snails abound, as in the case of the far-famed Portland mutton, it might be replied that snails of all sorts are indicators of limestone, and limestone of superior herbage; and here, upon the outcrop of the coal measures, as in Portland on that of the Purbeck beds, we encounter the very best snails and grass, the grass feeding the snails, and at the same time luxuriating on the substances indicated by their presence.

The first group of specimens (six in number) are Cyclas, representing a genus so called by Lamarck, from *cyclus*, a circle. In shape, however, they are rather elliptical, and convex or subglobose. These Cycladina exclusively inhabit fresh water; their residence is amongst the mud at the roots of plants. They are so closely allied to the Venerina as scarcely to be entitled to rank as a distinct family, except that those beautiful shells, which Linnæus named after the goddess Venus, are not all fresh-water shells, but all are mollusca, or, as Macgillivray and some other writers prefer to call them, Malacozoa, or soft animals, as more appropriately designating the group. They all likewise belong to the same class of mollusca, namely, *Tropiopoda lamellibranchiata*, so called from two characteristic circumstances; the first, signifying a keel, or turning foot, being derived from a compressed muscular foot attached to the creature's abdomen; and the second from its thin plates or gills, on the sides of the body within the mantle, serving as respiratory organs. As our illustrations are of the natural size, and, moreover, as the mere shell gives no conception of the animal structure, it may readily be surmised that all these organs are exceedingly minute. Indeed, in the largest species of the three now figured, the *Cyclas rivicola* (River Cycle), the maximum measurement is five-eighths of an inch in length and seven-eighths in breadth; but as the Cyclas are all ovoviparous, thriving well and breeding in confinement, the cultivator of a vivarium, who does not mind the accession of one full of mud, may rear them by themselves. The *C. rivicola*, the largest of the family, is plentiful in the Thames at Battersea, as well as

near the Red House; as also at Oxford, and in all the slow rivers of England, although, perhaps, it is found largest at Burton-on-the-Trent.

The *Cyclas cornea*, or Horny Cycle, is not so large. The River Cycle is brown in colour, with some dark zones, and inclining to green; the Horny Cycle is also brownish,



1. 3.

2 4. 6.

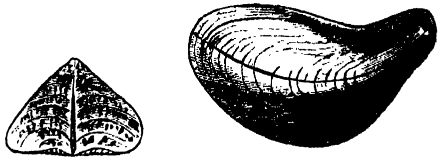
1. Cyclas rivicola (the River Cycle), *Leach*. 2. Ditto, *ibid*. 3. C. cornea (the Horny Cycle), *Linnæus*. 4. Ditto, *ibid*. 5. C. calyculata (the Capped Cycle), *Draparnaud*. 6. Ditto, *ibid*.

and though seldom more than half the size of the other, is more ventricose, thinner, and more transparent in the shell. It varies, however, so considerably that several varieties of it are recognized as distinct, particularly a straw or lemon-coloured variety. Most stagnant pools, ditches, and streams in Great Britain and Ireland produce it. Its length may be given as about three and a half eighths; its breadth as half an inch (four eighths).

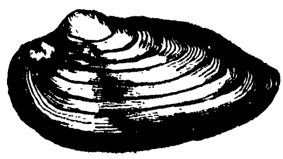
The small, delicate, shining White-capped Cycle, *Cyclas calyculata*, also figured, though locally abundant near Beeston, is not so common. It also is an inhabitant of stagnant water, is in size about a quarter of an inch each way, and takes its name from the umbones, in contrast to the general character of the shell, which is flatter and more compressed than other shells of the family, being narrow and projecting like little caps. Capt. Thomas Brown considered it a very rare and local species, found principally in the lakes of Westmoreland, but not uncommon in pits and ponds near Manchester.

The next group of bivalves is led off by the *Dreissena polymorpha* (Figs. 7 and 8) of Van Benenden, in which we approach the character of the sea mussel. From being principally met with, in truth, in the London Commercial Docks, and in the Bridgewater and other canals, it is commonly regarded as a shell of foreign origin, which may possibly have reached this island attached to timber (being a native of the Volga or continental rivers) or the bottoms of vessels, for, though a fresh-water shell, it can live a considerable time in the sea. When it attaches itself in clusters to a substance by its beard, it seldom quits it, but clings to wood, stones, or other shells, increasing in size and deepening in its chocolate-coloured stripes or markings. In length and breadth it varies from an inch and five-eighths to an inch in size. It is evident, from shells dropped about the banks of lakes frequented by water-fowl, that they feed on the *Dreissena*, which is now widely spread over England.

The *Unio tumidus* and *U. pictorum* (Figs. 9 and 10) belong to the family of the Nayades.



7. 8.

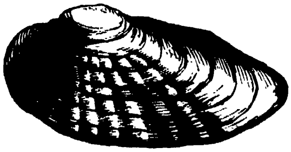


9.

7, 8. Dreissena polymorpha (the Zebra Dreissena), *Pallas*. 9. Unio tumidus (the Tumid Union), *Retzius*.

Of the two, the *U. tumidus* is the more solid, although this shell tapers behind, and is

broader than *U. pictorum.* It inhabits slow rivers and canals, having been found in the New River, at London, and the Avon, at Leamington, as well as near Beeston, Notts., where it is an abundant shell. Its shining epidermis is olive rayed with green; but sometimes the shell is of a uniform pale brown, and not rayed. Its length is generally about half its breadth. The *U. pictorum* is more varied in form, but is most



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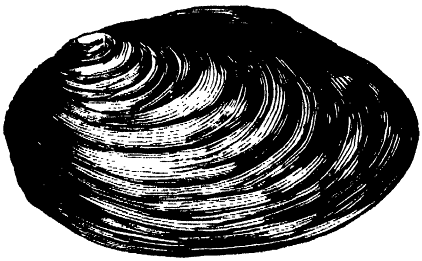


11.

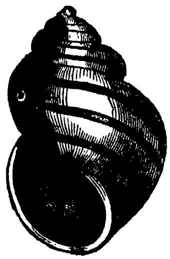
10. Unio pictorum (the Painter's Union), *Linnæus.*
11. Anodonta cygnea (Swan Fresh-water Mussel), *ibid.*

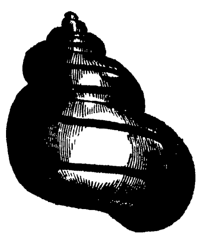
commonly an oval "produced." It is covered with a smooth, shining, yellowish-green epidermis. This beautifully-coloured and striated shell is found in the Ouse (near York), the Aire (Skipton), and the Severn (Shrewsbury). When it is noticed that its length is ordinarily little more than two-fifths of its breadth, and its thickness, indeed, more than its length, it will hardly be necessary to remind the general reader that the length of a shell is not taken in its longest direction, but from the hinge to the lip of the valve at the centre. The remaining figure of this group, *Anodonta cygnea,* or toothless swan fresh-water mussel, attaining a size considerably larger than any other fresh-water British shell, is yet a much more fragile object than the Unios. None of the British mollusca are, however, more varied in size or in form. As an example of wondrous reproductive power this creature is remarkable, since, as Professor Forbes remarks, "in spring and summer the branchial leaflets are filled with minute, yet completely shelled young, to the number of many thousands." The maximum size exceeds in breadth six, and in length three inches; but the shells are found of all sizes, as most of the Anodons undergo considerable change in their progress from the young to the adult state; Forbes, indeed, recognizes only one Anodonta in Great Britain, holding the different varieties of other naturalists to be merely several forms of the same mollusc. It is everywhere abundant in Great Britain and Ireland, and has also a range all over Europe, water-fowl being said to feed upon it. To these, the bivalve shells

12. 13.

12, 13. Neritina fluviatilis (the River Neritine), *Linnæus.*

of our bag, we shall for the present add only the small groups of univalve *Neritina* (Figs. 12 and 13), and the *Paludinidæ* family, comprising the *Paludina* (Figs. 14 and 15), *Bi-*

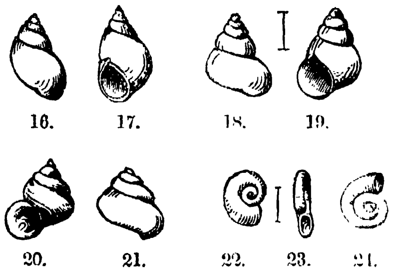




14. 15.

14, 15. Paludina vivipara (Common Marsh Shell), *Linnæus.*

thinia (Figs. 16, 17, 18, 19), and *Valvata* (Figs. 20, 21, 22, 23, and 24), because we



16, 17. Bithinia tentaculata (the Tentacled Bithinia). 18, 19. Bithinia Leachii (Dr. Leach's Bithinia), *Sheppard*. 20, 21. Valvata piscinalis (the Stream Valve Shell), *Müller*. 22, 23, 24. Valvata cristata (the Crested Valve Shell), *ibid.*

must frankly own, that apart from the more interesting miscellany of shells, more or less rare, which must be reserved for the last, the bulk of our bagful consists of slugs and snails, the former only represented by small shields, more or less microscopical, dissected from their bodies. The *Neritina fluviatilis* (or River Neritine) is the only branch of the tropical Neritidæ family found in England, being, indeed, the strongest, the thickest, and most solid in form, of all the British mollusca. It is to be found adhering to stones, and to other shells, especially defunct, but sometimes living valves (as *Dreissena polymorpha*, *Paludina vivipara*, *Anodonta cygnea*, and *Unio pictorum*), and for the most part completely covering whatever it is attached to, except in winter, when abandoning the attachment, it lies dormant in the mud of the slow rivers, lakes, and canals it inhabits. This animal, unlike those hitherto described, belongs to the *Gasteropoda*, so called from their muscular disc, or foot for creeping, attached to the body underneath; slugs, snails, whelks, buccines, and other common mollusca, are all in fact familiar examples of this class, as may be presumed from their possession of the fleshy disk or foot. In size the *Neritina fluviatilis* is only three-eighths of an inch long, by a quarter of an inch broad. But beneath the brown or greenish epidermis, which covers the external surface of the shell, a good lens will disclose beautiful streaky spots, or mottling of white purplish brown, pale brown, or deep umber, sometimes arranged in special bands. The last convolution of the few whorls which this shell possesses is larger than the others. The creature possesses an opening, or operculum, of nearly an orange colour, with a red band round the edge. The large stones under water in the Trent, at the depth of ten or twelve inches, are encrusted with its young in September. To be brief about the *Palludina*, *Bithinia*, and *Valvata*, these, it will be noticed, are spiral shells, of no great magnitude, and they are without the bronchial tube (asiphonata); the first being the common marsh shell, the second taking its name from dwelling in the deep, and the third the abundant stream valve shell. The animal of the marsh shell, called *vivipara*, from producing young, exhibits a new development, possessing, as it does, two contractile tapering tentacula bearing eyes on prominences at the base. It has also a thin horny operculum. The shell is turbinated, or twisted. M. Chauteraux found that in autumn the female contained twenty or thirty eggs, and brought forth at two months.* It is the aquatic species, nearest in appearance to the garden snail. In colour it is olive-green, with reddish-brown bands. *Bithinia tentaculata* is quite an English shell, commonly diffused, but becoming more and more scarce in the northern counties. In ditches, brooks, canals, and rivers, it is found clinging to aquatic plants; and it is one of those shells that thrive in confinement. Of its five convolutions, the lower is larger than the other four put together, or

* Mr. Woodward (British Museum) says, "Embryos scarcely visible to the naked eye have a well-formed shell, ornamented with epidermal fringes; a foot and operculum; and the head has long, delicate tentacula, and very distinct black eyes."

nearly so. *Bithinia Leachii* is rather more rare, being principally confined to the south of England, although it occurs on the Trent also, otherwise it would not be in our bag. It can live in brackish water, under tidal influence, although an inhabitant of lakes, rivers, canals, and ditches. It lays about twelve eggs, and attaches them to the stems of aquatic plants. *Valvata piscinalis* is very abundant; it also lays eggs, about sixty or eighty in number, and fixes them to stones and aquatic plants. *Valvata cristata* is quite minute, being found on the aquatic vegetation of lakes, ponds, canals, and ditches.

WILLIAM WALLACE FYFE.

PRIMITIVE WEAPONS AND WORKS OF ART.

THE light of science, like the light of day, breaks gradually on the human understanding. At first, nothing is visible but the objects lying close at hand; soon, however, the distance widens; unsuspected points come, one by one, prominently into view; and at last the delighted eye takes in the complete circuit of an extensive horizon.

As with terrestrial space, so it is with earthly time. Within the memory of man, history, geology, creation even, were supposed to lie within the period of a few thousand years. Astronomy (through the means of the precession of the equinoxes) first raised doubts as to the accuracy of such narrow limits. Geology stretched out the lapse of past time over an indefinitely wide extent; and, finally, a French gentleman, obstinately searching the gravel-pits of the valley of the Somme, assigns to the human race a longevity which, till very lately, it was black heresy even to imagine.

But Commandant Maury, in his admirable "Physical Geography of the Sea," observes that as our knowledge of Nature and her laws has increased, so has our understanding of many passages of the Bible been improved. The Psalmist called the earth "the round world," yet for ages it was the most damnable heresy for Christian men to say the world is round; and, finally, sailors circumnavigated the globe, proved the Bible to be right, and saved Christian men of science from the stake.

A similar remark may be made respecting the history of the world's inhabitants. By behemoth the mammoth is supposed to be meant, which now appears to have really been co-existent with earliest man. Isaiah says (lx. 17), "For brass I will bring gold, and for iron I will bring silver, and for wood brass, and for stones iron." Man has passed through an Iron Age; the discoveries of M. Boucher de Perthes prove that man has struggled to maintain his existence through an Age of Wood and Stone. Metals were not yet known.

The world has long been puzzled by the inscrutable age of Celtic remains, and of what are called Druidical monuments. Our imagination commonly throws the Celtic period so far back into time as to make it an epoch without historical date, and our imagination appears to be in the right. For the mysterious weapons known as "celts," with many other kindred curiosities, are now swept out of history, to repose henceforth within the measureless domain of geology. Modern science has demonstrated the world to be infinitely older than the mass of commentators had suspected; science now claims for the human race a much longer line of ancestors than is generally accorded to it. Before the Iron Age, the Silver Age, and the

Golden Age, there was an Age of Stone; man knew not metals, but he fabricated and made use of wood, horn, and especially flint. If fossil man is still a desideratum—and the finding him is only a question of time, a matter of patience—his fossil handiworks, unquestionably such, are to be found in plenty. No animal (except man) of which we have the slightest trace or relic is capable of fashioning knives, axes, spear-heads, arrow-heads, symbols, toys, personal ornaments, and tools. If such are found in a truly fossil state, the unavoidable inference is that man must have been the living companion of numerous extinct animals. He must have shared the forest with the mammoth, have chased the gigantic Irish deer, feasted on the flesh of the aurochs, and trembled at the sight and the voice of the monstrous tiger of our caverns.

But what a life to lead! Intruder amongst, not masters of, a mighty crowd of powerful brutes. With his rude or feeble means of defence and offence, with the gaunt carnivoræ stalking around and glaring at him by night and by day, with colossal bears, hyenas, and felidæ multiplying around him, with no possible check *from him*, man was the victim and the prey. Even beasts of comparatively milder natures would unconsciously and unintentionally be his enemies, and not his friends; his servants least of all. Little would he be able to withstand the shock of angry bulls and encroaching elephants; attempts at culture would be instantly devoured or trodden under foot; a persecuted fugitive, man would owe his only safety to cunning and flight. For security, he would have to retreat to the depths of the semi-liquid swamp, or to climb to a lodging amidst the steepest rocks. And what a race of men! As the polished European is to the Red Indian savage, so would the Red Indian be to that poor, primitive, imperfect human being.

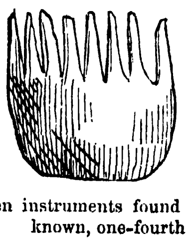
The relics of this bygone race appear, at first sight, exceeding trifling and contemptible, for they are limited to bones and rudely-cut stones. Here we find no inscriptions, medals, bas-reliefs, nor statues; nor are such needed to prove that a land has been tenanted by human inhabitants. Our pains are rewarded by no vases elegant in their outline or rich in their material; we gather nothing but bones, potsherds of clay, and scarcely-polished pieces of flint. But for the observer in whose eyes the demonstration of a truth is of greater price than the possession of a gem, value consists neither in finished workmanship nor in money's worth. In his eyes the most beautiful object is that which most helps him to a sure conclusion.

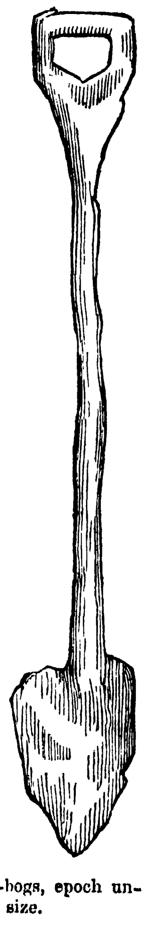
These first attempts of human art are like the rudimental organs and embryos preserved in anatomical museums. They are more; instead of illustrating the material progress of the corporeal frame of an individual, they mark his moral development—the advances made by his intelligence and his inventive genius. So far from despising the rudeness of their execution and the coarseness of their material, we should treasure these early efforts of our race with a similar interest to that with which we watch the first attempts of our children's budding intellect. These venerable, though humble relics—arms, utensils, idols, symbols—not only betray the existence of a people, their habits of life, their means of existence or of satisfying the necessities of the moment; they also give us a significant clue to the thoughts and the conscience of our antediluvian ancestors. They prove that they had a notion of the future, a faith, religious longings; in short, that they had caught a glimpse of the divinity. The first men who united their efforts to raise a monumental stone, who hewed it into shape, who battered it into the coarse resemblance of some living object, came forth, by that very act, from association with mere brute animals, and ceased to grovel utterly in the dust.

One summer's evening of 1826, while M. Boucher de Perthes was examining a sand-pit at the extremity of the Faubourg Saint-Gilles, at Abbeville, the idea struck him that manufactured flints might, perhaps, be found in tertiary beds. Years passed, and he searched numerous localities in vain. At last, at a place called the "Banc de l'Hopital," near his own place, he found a flint about five inches long, from which two splinters had evidently been struck off. Every one to whom it was shown said that it was the result of accident. He found a second, and again a third, exactly similar. Learned archæologists would not look at them. M. de Perthes felt convinced that he had traced the hand of man, and persisted in his researches. The dons of French science not only would not believe that he had found works of humanity mixed up with virgin diluvium; they would not even take the trouble to listen to his statements, nor examine the specimens which he had found. He collected at Abbeville a rich museum of antediluvian antiquities, whose doors were liberally opened to whosoever would—all to little purpose. Incredulity shut her eyes to his discoveries, and stifled the results of his efforts, as with a wet and heavy blanket.

But, urged our enthusiast, archæology, like geology, is as yet no more than an infant science. It is only by penetrating into the depths of the earth, that you will arrive at really great discoveries. We have not yet pierced through the epidermis; we have merely scratched its upper surface, and raised a little dust. How will you demonstrate the ancientness of the population of any given soil? By the antiquity of the objects found in it. How can we measure that antiquity? By the materials, the workmanship, and above all by the subterranean position of the objects. We thereby admit a sort of scale of life—a superposition of strata formed by the relics of generations; and we seek, in each one of these strata, indications of the history of those generations. Consequently, the deepest strata will illustrate the most ancient populations.

It frequently happens, in the valley of the Somme, that after having traversed the stratum of Roman soil, and of the soil of the Gauls, you will reach a Celtic deposit, which you will recognize by the nature of the pottery. There you will find an axe of stone, characteristic, in your eyes, of that epoch when iron still was rare. Sounding deeper, you meet with a stratum of turf of no great thickness, but whose ancient formation, if you examine its elements, appears incontestable. Beneath this stratum is a bed of sand, and in this bed another axe. When you are convinced that this axe is in its natural place, and has not in any way been introduced into the sand, it is evident that the epoch of the fabrication of the second axe is separated from the epoch of the first by the series of ages requisite for the formation of the bed of turf—





Wooden instruments found in turf-bogs, epoch unknown, one-fourth natural size.

an interval of which you are able to form an approximate estimate. You conclude that, during this period, the inhabitants have been, if not the same, at least in an analogous condition; which is confirmed by historical and traditional probability. The primitive

Gauls, composed of wandering tribes, and living by fishing and the chase, like hordes of North American savages, long remained stationary, without making any sensible progress in manufactures and the arts.

Digging still farther down, you arrive at a level which you are at first tempted to regard as virgin earth, which has never borne the footsteps of man. Nevertheless, there are human traces; after a little study, you cannot mistake them. A mere notch in a bone made with the edge of a flint; a splinter knocked off the flint with an evidence of intention; a single bit of wood cut and not broken; prove the presence of a human hand as clearly as a carved inscription. The most intelligent animal—the elephant, the dog, or the ape, is incapable of making that notch. He breaks or gnaws the wood; he neither cuts nor slices it.

The accuracy of this reasoning was established by the visits of English geologists, who dared to burst through the cautious scepticism adopted by their brethren of France. Mr. Prestwich says, "I myself detached a flint partly fashioned into an axe, buried in the gravel at a depth of more than five yards. A labourer, who was working in a trench, disinterred, without observing them, a couple of axes, which we picked up from the thrown out gravel." Sir Charles Lyell says, "The strata containing these rude instruments repose immediately upon the chalk, and belong to the period which followed the formation of the pliocene beds; that is, to the quaternary period. The antiquity of the Amiens and Abbeville flint instruments is very great, when compared with the time embraced by history and even by tradition. The disappearance of the elephant, the rhinoceros, and other genera of quadrupeds now strangers to Europe, implies, in all probability, that a wide lapse of time separates the epoch when these fossil instruments were fashioned, from that when the Romans invaded Gaul." We will now set before the reader a sample, not only of the instruments, but of the images or symbols also.

Fig. 1 is a rough tool, whose utility will be evident, even before observing that it has been fashioned by hand; it may be employed either for hollowing out or for piercing. Fig. 2 is another knife of the same description.

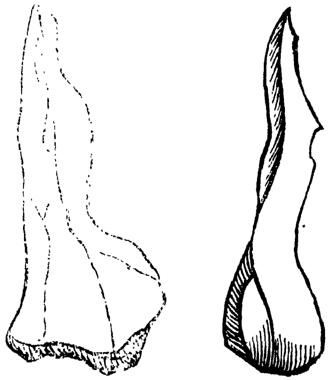


FIG. 1. FIG. 2.

Knives from the Diluvians. One-third natural size.

Both are formed out of oblong flints with a naturally rounded base, which has been allowed to remain in its original state, in order to give greater strength to the handle. The remaining portion of the stone has been rudely reduced in thickness, so as to leave a sharp and curiously twisted edge. The substance of these flints is blackish.

Respecting the symbols: The images of stone found in Celtic tombs are ordinarily those of the animals whose bones are found in the same deposits. The same fact occurs in the diluvian bed; but the cause is different. In the case of the Celtic remains, the juxtaposition was effected by the hand of man; in the diluvian beds, by the agency of the waters.

The remarkable analogy between the figures of the Celtic tombs and the animals which lived at that period, is not less striking with those obtained from the diluvian beds. The reason is simple: the antediluvian peoples, like the Celtic people, and like people

at the present day, could only reproduce copies of species which they had seen; and they copied those which they beheld the most

Fig. 3.—Antediluvian figure, one-third natural size.

frequently. Among these species some were common to both the Celtic and the diluvian periods; bears, stags, boars, and oxen. But,

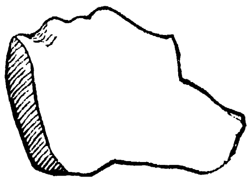


Fig. 4.—One-third natural size.

besides these, the diluvian beds offer many figures which are never found in Celtic deposits, notably of elephants and rhinoceroses.

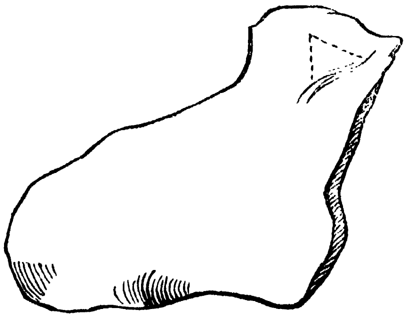


Fig. 5.—One-third natural size.

There are also images of creatures whose types are now unknown to us; nevertheless, the abundance of their copies in stone is a proof that such creatures once existed.

Fig. 3 is a human bust, which is allowed

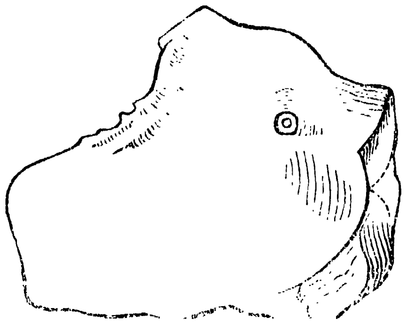


Fig. 6.—One-third natural size.

to be problematical. Many dogs' heads, such as Fig. 4, surprise by the freshness of their chiselling; the cause of their preserva-

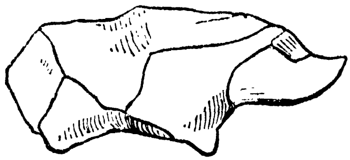


Fig. 7.—One-third natural size.

tion is satisfactorily explained by M. de Perthes. Fig. 5 is a bear sitting on his hind quarters, whose character is not badly expressed. Fig. 6 is a hippopotamus's head. Symbols are frequently found which appear to represent the enormous mastodons and

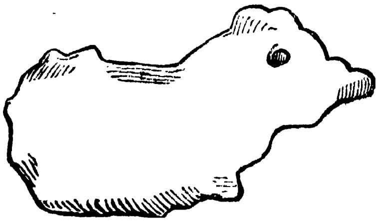


Fig. 8.—One-third natural size.

antediluvian elephants, whose bones we discover mixed pell-mell with their portraits in

flint, one of which is figured by No. 7. At the period of the great inundation which formed those deposits, these animals were very common in Europe, as is proved by the abundance of their remains. There are also symbols of ruminant animals, of which Fig. 8 is one.

The topic before us is the more exciting because similar excessively ancient antiquities are to be found in England, as well as in many parts of the continents of Europe and North America. Our space forbids us to do more than communicate the substance and the bearing of these facts to those to whom they may be unknown, and to refer the student to the two volumes, full of interest, "Antiquités Celtiques et Antediluviennes," which M. Boucher de Perthes has so disinterestedly given to the world.

HENRY SAXON.

LIGHT ANALYZED.

DISCOVERY follows discovery so rapidly that it is all but impossible to keep up with the advancement of the various branches of science. Sometimes a new subject is suddenly thrust upon us to dazzle us with wonder and admiration; as, for instance, Newton's announcement of the law of gravitation. But, usually, the discoveries advance by slow but sure means, atom upon atom of truth at length builds up a great truth; the careful and laborious work of many men is perhaps required in order to clear away clouds of darkness and error that have surrounded any particular new subject.

One of the great triumphs of intellect is the power given to the philosopher to predict with certainty that some great truth will be unfolded; and, indeed, to point out how the discovery is to be made. Let the true philosopher only once insert the small edge of the wedge of knowledge into any subject, and time alone is required to raise up from the foundation a structure that will last for ever —a structure that time cannot crumble into pieces. We have numerous instances of important predictions, scarcely believed at the time, but which have eventually been verified.

Professor Owen looked at a bone, and then told the world that a huge bird had lived in New Zealand, and might even then be alive. He foretold its size, described its nest, and the dimension of its eggs. Months passed away, and then more bones arrived, until the Professor had constructed the skeleton of a bird exceeding all others in its size. Halley announced the reappearance of his comet, and although he did not live to see his prediction verified, nevertheless the comet shone upon his tombstone. Bode predicted the law of planetary distances, and although at the time a gap occurred between Mars and Jupiter, subsequent astronomers have found a ring of seventy small planets at the distance from the sun ascribed by Bode. The influence of one planet upon another caused Leverrier and Adams to determine the position of the planet Neptune before it had been discovered, and at the exact place pointed out by Leverrier, Dr. Galle found the planet. And now, Bunsen, from spectrum observations, declares that two bright blue lines which he had not seen before were caused by a new metal, and subsequent research proved the correctness of his reasoning; he has found the metal, which he has named Cœsium, and whilst experimenting on this new metal, two beautiful red lines situated beyond the ultra red portion of the solar spectrum were observed; this Bunsen pronounced to belong to a second new metal, which he has named Rubidium.

And this leads us to the subject of which we are about to say a few words. It has been found that if we examine, by means of the prism, the light of bodies in a state of combustion we shall become aware that a given definite series of rays proceed only from a certain element,' and that as one element always presents the same series of lines or bands, these rays may be used as a sure indication.

By light we may look a substance through and through, and observe every kind of atom it contains; indeed, in order to learn of what a substance is made, we have only to drop a particle of it into a flame and then examine it telescopically. Thus we are enabled to see into the very composition of matter, for, visible as lines of many-coloured light, we behold the natural sign of every element that happens to be present, even if the quantity does not exceed the hundred millionth of a grain. To Professor Kirchoff and to Professor Bunsen we owe our warmest thanks for disclosing these great secrets of Nature. It is true that the Rev. M. Morgan, in 1785, examined, by the aid of the prism, the light of bodies in a state of combustion; that Dr. Wollaston in 1802, Fraunhofer in 1814, Mr. H. F. Talbot in 1836, Sir John Herschel, Sir David Brewster, Professor Wheatstone, Dr. W. A. Miller, M. A. Masson, Professor Stokes, Professor W. Swan, A. J. Angström, Dr. J. H. Gladstone, Mr. Crooks, Mr. Pearsall, and Professor Roscoe, each worked at the subject, and did great service. Professor Swan tells us that a portion of chloride of sodium weighing less than the millionth part of a grain is sufficient to tinge a flame with bright yellow light, although this quantity of salt only contains one 2,570,000th part of a grain of metallic sodium.

The apparatus required consists of a prism and two small telescopes inclined at an angle of about 122°, and so placed on either side of the prism that the first telescope throws the examined light on the prism, and the other collects and transmits it to the eye. The prism is a hollow vessel, of which two sides are of plate glass inclined at an angle of 60°; this is filled with the liquid bisulphide of carbon on account of its uniform purity, and high refractive and dispersive power.

Turning to the results published by Bunsen and Kirchoff on six metals, we find that calcium, the metallic base of lime, exhibits a bright green line, and an intensely bright orange line (the latter near the red region of the solar spectrum), and that these lines are apparent when only 100,000,000th part of a grain of lime is used; that barium gave many green and orange lines; that strontium exhibited six splendid red bands, one orange band, and a beautiful blue line, the latter separated by a considerable interval from the others, and that one millionth part of a grain of strontia can be detected; that potassium gives a widely extended continuous spectrum containing only two characteristic lines; that lithium, always thought to be very rare in Nature, has, by the spectrum investigation, been found to be occurring in almost all bodies, instead of occurring only, as it was before thought, in four varieties of mica. Bunsen found it consisted of a single intensely brilliant crimson line and an orange line, and that the 70,000,000th part of a grain can be observed; with this small quantity, if a ray of crimson light is found in the proper situation, lithium must be present. And, lastly, that sodium consists of two very close powerful yellow lines, so readily to be seen that the 180,000,000th part of a grain of soda may be detected. Sodium is always present in the air; indeed, by the spectrum analysis all rain water has been found impregnated with salt.

How difficult is this new process of analysis to the hitherto long and weary chemical processes; and, in comparison, how short is the process of simply reducing a substance

to a volatile form, and then looking at it through a telescope.

There is one new use of this important discovery yet to be mentioned; it is the determination of the chemical composition of self-luminous bodies. The sun and the stars can by this means be examined. If we examine a star, and find the characteristic lines of calcium and sodium exhibited, we are prepared to declare that calcium and sodium must exist in that enormously distant object. Kirchoff, from his examination, has already proved that the sun's atmosphere contains sodium, magnesium, iron, chromium, and nickel; that the stars Pollux, Capella, Procyon, and Betelgeus, contain sodium, and that as regards Sirius and Castor very little sodium exists. In course of time every principal star will have been analyzed, and this new field of inquiry will have enriched our knowledge of these distant bodies far beyond our most sanguine expectations.

Kirchoff announces that any element in the gaseous condition has the power of both radiating and absorbing light-rays, and that if the radiated light is more intense than that absorbed, the body appears luminous; but if the rays falling upon it are the most intense, the body gives out less light than it absorbs, and, in comparison, is relatively dark.

This great discovery is one which must attract wide attention, and therefore, we may look forward to other truths being unfolded, and shall hope ere long to return to the subject.

E. J. LOWE.

WAYSIDE WEEDS AND THEIR TEACHINGS.

HANDFUL VI. CONCLUDED.

"If God so clothe the grass of the field."

PLANT CLOTHING!—A very varied wardrobe have these "lilies of the field." The richly coloured petals, sometimes brightly coloured calyx or bract, the leaves of every surface variety, the bright shining stems of the grasses, or of the smooth, richly spotted hemlock, the bark of birch, beech, oak, or pine, are all portions of our plant clothing. True it is that much of the colour which varies the plant exterior belongs rather to the colour cells just below the plant covering or cuticle, than to the cuticle itself, but still we may legitimately regard all as part of the array which God has given. A covering which permits the free transmission of colour must, necessarily, be extremely thin and transparent, as any one may see who will take the trouble to carefully strip the cuticle from a leaf; put under a tolerably good microscope, it will exhibit that appearance shown in Fig. 101, the irregular lines marking the boundaries of the flattened cells which form the cuticle. These cells, which are in one or more layers, although generally transparent, are occasionally coloured, and in many instances contain waxy or siliceous (flint substance) deposits, the latter particularly in the stems of the grass tribes, and more especially in those of the horse-tails or "jointed ferns," we do not, however, yet number the latter among our acquaintance.

In these the cells of the cuticle contain the silex grains so abundantly, and withal so symmetrically arranged, that it is ible for all the real vegetable substances to be removed, and still the stem will retain its form. Moreover, the presence of this crystalline sand, for it is nothing

else, fine and minute as it must necessarily be, renders these comparatively unvalued plants of some commercial importance as polishing agents to the cabinet-maker, the

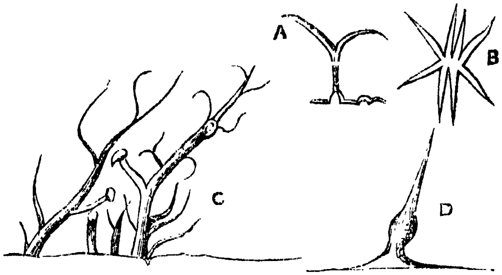


FIG. 100.—Hairs from plant surfaces magnified. A, Forked hair; B, Stellate or star-shaped; C, Branched and gland-bearing hair; D, Tubular hair of nettle with poison-gland at its base.

whitesmith, and others. We shall have more to say of them in a future paper.

It is not, however, colour only which the plant cuticle allows to pass, but, what is much more important to the vegetable economy, it permits the free ingress and egress of moisture, and air or gases, not indeed through its entire surface, but by means of the little breathing pores or stomates (Fig. 101 A), which are so thickly scattered over the plant surface; in most, on the under surfaces of the leaves chiefly, the principal exception to this being in the case of floating leaves of aquatic plants, where, obviously, the stomates would be useless on the under surface, and, consequently, we find them on the upper. Each little stomate, as represented, is composed of a couple of oblong cells, with an opening between them communicating with the cell tissues which compose the substance of the leaf. These little cells are the door-keepers, for, being hygrometric, that is, affected by the presence or absence of moisture, in dry weather they contract, and by shutting up the little opening between them prevent the plant losing more moisture by evaporation than it can afford; in moist weather the reverse takes place. It would be out of place here to enter into a consideration of plant respiration and digestion, which go on in the leaves mainly by the communication effected between the plant tissues and the atmosphere through these sensitive little pores; suffice it for us that we see how this cuticle of the plant, the epidermis it is called by some, contributes essentially to a function on which not only the health and growth of the vegetable world depend, but also, by the purification of the air, effected by vegetable respiration, the health of the animal creation likewise. The stomates have been alluded to with reference only to the leaves; they occur, however, but not so abundantly, on most other parts of vegetables, varying greatly in number upon different plants. On the roots underground, where manifestly they would be of little or no use, the stomates do not occur.

Beautiful, however, as may be the plant covering, whether in its own bright polished surfaces, or in the transparency which per-

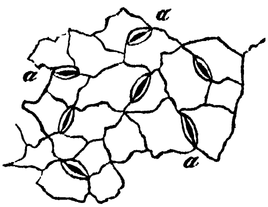


FIG. 101.—Plant cuticle magnified, showing outlines of cells. *a, a, a,* Stomates or breathing pores.

mits the passage of the brilliant colours which tinge the cells beneath it, we find its beauty and variety wonderfully augmented by the manifold difference of its hair appendages. Hairs have we of every form, simple as in most plants, stellate or star-shaped (Fig. 100 B), beaded, forked (Fig. 100 A), gland-bearing (Fig. 100 C), and soft as down, satiny, as in the mountain lady's-mantle, or stiff and rough, until they go a step farther and be-

come hardened into the prickles of our roses and brambles; venomous, too, are some hairs, as the nettle frequently reminds us, whilst some of the glandular kind secrete an oily, sticky fluid; lastly, we have the chaffy scale clothing of the young ferns, another cuticular appendage. It would be superfluous to offer our readers many examples of a plant character so easily accessible as the hair appendages of the cuticle, and we would not deprive them of the pleasure of examining, as they can so easily do, for themselves, by merely plucking not only leaf after leaf, but plant after plant, in their walks, and using their lens. We mention plant as well as leaf, because the arrangement of the hairs on plant stems is often interesting and characteristic, as in the common speedwell, common chickweed, etc. We must not forget to mention that one little spot, and one only of the entire plant, the stigma of the blossom, is left uncovered by the cuticle.

SPENCER THOMSON, M.D.

WENHAM'S BINOCULAR MICROSCOPE.

MANY attempts have been made since the invention of the stereoscope to adapt its principles to the microscope, and thus give microscopists the advantages of binocular vision. After several fruitless efforts, this has been successfully accomplished by Mr. F. H. Wenham, who, by a simple and beautiful invention, has succeeded in producing the most perfect stereoscopic effect.

The result is obtained by the introduction of a small, but very accurately formed, double reflecting prism, immediately above the object-glass, so as to intercept half the rays of light which pass through it. Fig. 1 will explain the principle: A is the body of an ordinary microscope; at B a square hole is cut, through which the prism C is made to slide so far that its edge will just reach the central line of the objective, and should be made to draw back so as to clear the aperture altogether, when the tube A acts as a single microscope. When the prism is thrust in, it collects a portion of the rays, and reflects them to the opposite side of the tube, where an opening is made large enough to allow them to pass through, into the supplementary body, E, which in size corresponds to the main tube; the remainder of the rays pass uninterruptedly up the principal body.

Fig. 2 is an enlarged outline of the prism. Let E E be a ray of light having passed through the object-glass and entering the

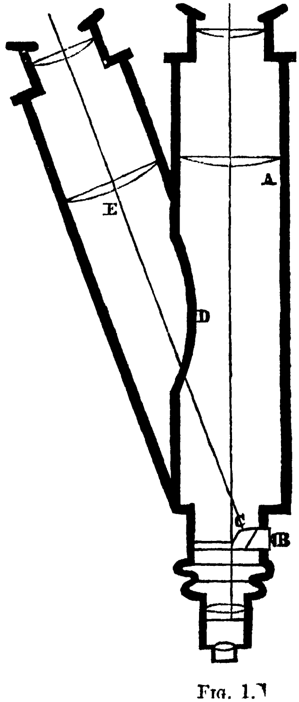


FIG. 1.

prism at right angles at the point F; passing on, it is intercepted by the surface A B, which

being inclined within the angle of total reflection, the ray is reflected towards H, from which point it is again reflected in the direction required. If the prism be correctly made, and of the smallest size possible for admitting the pencil, the difference between the direct and reflected image is scarcely observable; a faulty prism therefore can be easily detected.

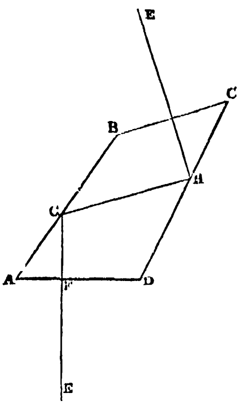


FIG. 2.

The adjustment for difference of distance between the eyes is effected by means of the draw tubes; if they are at the utmost limit of proximity when close in, by drawing them out they can be made to suit every position of eyesight. This is very conveniently done by means of a rack and pinion movement, as shown in Fig. 3.

The opaque principle of illumination should be used in all cases where possible, as this gives to objects a more natural appearance. The effect upon looking through a binocular microscope for the first time is very striking; many peculiarities are instantly presented to the eye, which with a single body would be observed with difficulty. The instrument figured is one of those exhibited by Messrs. Crouch and Coldwells, at the Manchester Exhibition of Science and Art. H. S.

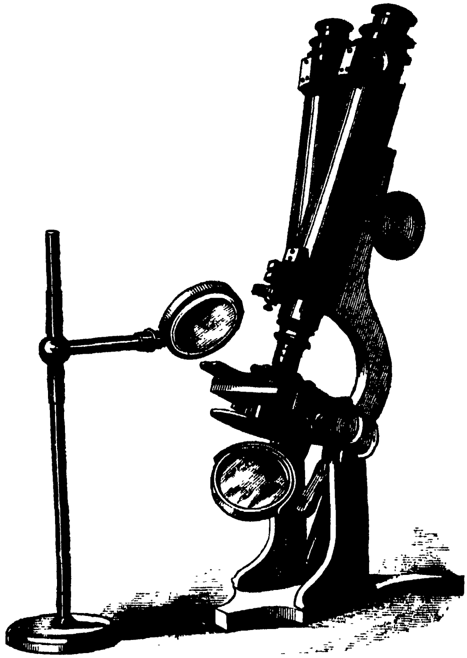


FIG. 3.

THE ALLIGATORS OF DEMERARA.

STRETCHING along the northern coast of South America for nearly a thousand miles is a narrow belt of low-lying land, exhaustlessly fertile, dismally unhealthy, abounding in swamps, and therefore the paradise of musquitoes, snakes, and alligators. Part of this belt belongs to Portugal, and is called Portuguese Guiana; following that is British Guiana; next is Surinam, or Dutch Guiana; and the last division is Cayenne, or French Guiana, the unhappy prison-home of persons *suspects* or proscrits by the French Government. This amazing belt is entirely composed of the rich alluvial soil* brought down

* Mud, in short, and nothing but mud. Not many years ago I had great difficulty in explaining to the

by the Orinoque, Amazon, Essequito, Demerara, Berbice, and other mighty South American rivers. Rising in the Andes, their streams gather volume from tributaries as they traverse the plains and table-lands of the interior, bringing down with them vast quantities of decayed vegetable matter (silt), and thus, in the course of unknown geologic periods, have added a thousand miles in length and ten to fifteen miles of breadth of land—a mud fringe, in fact—to the originally naked granite shores of the continent.

In one of these Guianas I was some time a resident, and a more undesirable domicile it would be difficult to imagine. It almost always rains there, and it never rains but it pours. In Jamaica and the other West India islands, the rainy seasons are pretty regular in April and October, but in Guiana* it is otherwise. "It is a wet country this," I one day said to an old planter. "Yes," said he, "I have been here twenty years, and reckon the first rainy season the first nine months of the year, and the second the last three."

In such a "dismal swamp" as this, where the vegetation is wondrously rapid and rank, alligators are sure to abound, and a few words on the nature and habits of these universally hated and dreaded reptiles may find an appropriate place in the pages of RECREATIVE SCIENCE. Their huge prototypes, the icthyosaurus, pleisiosaurus, and others, so admirably modelled by Waterhouse Hawkins, Esq., in the grounds of the Crystal Palace, are called enaliosaurians, or sea lizards; and it would not be amiss, perhaps, if we called the alligators, crocodiles, and gavials of the present era, potamosaurians, or river lizards.

The alligator, or cayman, of South America, is distinguished from the crocodile of the Nile and the gavial of the Ganges by having a much broader head and more depressed muzzle; but although these fierce reptiles are divided into these three groups, each characterized by its own physiological peculiarities, they are all fierce and carnivorous, generally taking their prey in the water, and retiring to some retreat on shore to devour it. In an old but valuable book of travels (Capt. Stedman's "Surinam," a rare work, written with great care, and illustrated admirably with engravings of natural history subjects) there occurs the following etymology of the word:—"Had it not been for an accident, these creatures would never have been known by any other name than that of crocodile;* for had the first navigators seen anything more resembling their form than a lizard, they would have adopted that which the Indians called them by, viz., the *cayman;* but the Spanish sailors remarking their great resemblance to that little reptile, called the first of them which they saw *lagarto,* or lizard. When our countrymen arrived and heard that name, they called the creature *a lagarto,* whence is derived the word *alligato,* or alligator."

There are two points of alligator life about which I think there is room for difference of opinion, and to which this paper is intended to refer as a trifling contribution towards natural history. The Hon. Richard Hill, the eminent naturalist of Jamaica, in a communication with which he favoured me in 1844, states that it "is the well-known habit of the alligator never to eat his food except in a state of *putridity.*" Mr. Gosse, who confesses "his lack of personal observation on these animals," adopts this theory, and so does Mr. Swainson. On the other hand, Mr. Waterton disputes it, and so do I. My attention was one morning called by our servant to a marvellous disappearance of our

boys of a school there what a *stone* was; they had never seen one, not even a pebble. There are none even upon the sea-beach, which is composed entirely of fragments of shell.

* "Guiana, Guyana, Guayana, or Guianna, received its name from the earliest Dutch settlers, who called it Guiana, or the wild coast."—*Sir R. H. Schomburgk.*

* Κροκος, saffron, and δυλος, fearing. The reason of this name I do not know.

ducks beneath the water of the "sea-trench" that nearly environed our house in Demerara. On going to the spot, I saw a duck bob down, not head foremost, but bodily, as if seized by something from beneath; presently down went another in similar fashion. Suspecting the cause, the surviving ducks were driven out, and presently there came up an alligator, exactly as Stedman describes him when lurking for his prey, "his muzzle alone above water, something like the stump of an old tree." Carefully looking around and seeing no ducks, he made no farther appearance; but the ducks he had eaten were in no state of putridity, being devoured then and there, upon the spot—bones, feathers, blood, and all in a live state of vain protestation against such an unexpected sepulchre.

On another occasion a Portuguese lad, close by my door, had the calf of his leg clean bitten out and eaten on the spot; though the boy happily escaped, faint and bleeding, to the bank. I know that the alligator was reposing on the mud bank of the adjoining trench enjoying his sunny repose, and digesting his human flesh without waiting for the process of putridity. Besides which, I have seen large alligators caught, skinned, and opened by the African negroes, who were preparing them for their own first course at dinner, and in the stomach of each the food was found in a perfect state of preservation, and far remote from decomposition. I suppose the alligator is not particular in his tastes, and that when he gets an abundant supply of fresh food he disgorges it, and hides it in the sedge on the banks, as a wise provision against a *dies non* in his predatory excursions; but that when this abundance of *pièce de résistance* does not occur, he makes the best use of present opportunities, judging wisely that a duck in the mouth is worth two in the mud.

The other point is this: Stedman, Gosse, Hill, and others, assert that the alligator lays its eggs in the sand, leaving them to be hatched by the sun. The negroes say the same, and I always thought so, till one day an incident occurred that altered this opinion. There is no sand in Demerara, not a grain; it is all mud, a continent of mud; and if alligators deposited their eggs in this, they would be baked in hard and dry, like gooseberries in a badly-made pie crust. I had heard that in "the bush" was the grave of an old Dutchman, a man of excellent memory, as a paternal master and a good Christian, remembered by his old slaves and their descendants "as the god of Cowrubanna;" one of them, "Old Achilles," told me that on massa's grave was a stone, "with some poetry on it, cut out in England, and sent out to be put on the burial ground." Resolved to find out this lone grave, I formed a small party of negroes, who, with their "maschettes," (cutlasses) cleared a way through the thick jungle, and on their broad shoulders carried me across the trenches we had to pass. On and on through a dark and sombre forest we went, for a couple of miles, to the resting-place of this old planter. The painful stillness of tropical forests has been noticed by all travellers. Imagination peoples them with birds of brightest plumage, and with numerous beasts of prey. But the reality is the silence of the valley of the shadow of death; a silence made all the more impressive by an occasional cry, or scream, or other unfamiliar sound. Now and then the monotony of our jungle walk was broken by the mournful cooing of the dove, or the church-like toll of the bell-bird (the *campanero*), or the scream of the macaw high overhead, or the singular shaking as of dry bones, that told us we were not far from the neighbourhood of the rattle-snake. Suddenly the foremost of our party called out, "Run, run, one big alligator here; she mind her nest; him fierce, eh?" With undignified haste we climbed the nearest trees and reconnoitred. A few feet before us was an alligator, watching, with maternal solicitude, her nest of dry sticks, beneath

whose protection she had placed her eggs. She was at least ten feet long, and as she opened her mouth, barking furiously at those who invaded her forest home, she displayed a set of teeth, and made so formidable a gape with her jaws, that we were glad to be out of her reach. She sat by the side of her nest, a pile apparently of dry wood, about eighteen inches high, beneath whose cover they were sheltered from rain, while sufficient heat from the sun was admitted to allow of their hatching. By the side of the nest the male and female alligators watch by turns, with a parental instinct that redeems them from their proverbial repulsiveness. No brooding hen ever watched her chickens more fiercely or fondly than did this alligator her nest. Barking fiercely, almost like a house-dog's bark when savage, she refused to stir one inch from the side of her expected progeny, although fired at five or six times. As she lay upon the ground, there was no chance of reaching a vital part, except through the eye, where at last, by a fortunate shot, she was hit, when she rolled over by her nest a piteous corpse. I own I was sorry to see this affectionate creature killed, yet, had I not seen it, I should have doubted the love of offspring which was thus manifested by a reptile that we have been accustomed to consider so void of natural affection as to leave its eggs untended in the sand, to be hatched by the sun, and, perhaps, afterwards to be devoured by the male alligator. Here the eggs were not deposited beneath the surface of the ground, but on the swampy ground was a little platform of sticks, on that some dried grass, on that a pyramidal hill of eggs, the whole surrounded and covered with round sticks, evidently broken off for the purpose, and beside which the mother was watching with fierce anxiety for the propagation of her kind. Thus, even the most repellent forms of animal life have something in common with its noblest types, just as we read in the oldest and best book, "that the huge sea monsters draw out their breasts that they may give suck unto their young."

I took the eggs, tied them up in my handkerchief, and placed them in a box of sand in the window of my library. In the course of a week or so I had some young alligators running about the room, that were soon consigned to spirits of wine. One I determined to preserve in the egg; accordingly I took off half of the shell with my penknife, and carefully pressing the youngster down, that the beautiful manner of his folding up might be seen, for the egg is not larger than a common hen's, I tied it round and round with black silk, and then put it in a bottle of spirits. There the young fellow still hangs in the cabinet of a friend. But while doing this the unhatched alligator, lying snugly in his shell, true to his nature, gave my finger a good smart nip, that made me start for a moment from my task.

This reminiscence is concluded. It may add a little to the slight knowledge of this shy and timid animal, dangerous to man only when provoked on land or disturbed in the water. In such relaxations as these I found great delight, amidst severe duties in the tropics, and can truly say with Bishop Heber, "In every ride I have taken, and in every wilderness in which my tent has been pitched, I have found enough to keep my mind from sinking into the languor and the apathy which have been regarded as natural to a tropical climate." W. Barrett.

THE PETROLEUM BAROMETER

Is formed by inclosing a certain quantity of oil of petroleum, with a portion of nitrogen, in a tube. This changes its bulk according to the density of the atmosphere, and if it proves to be reliable will be of great value as a portable instrument, which is unlikely to be impaired by accidents.

THE CHEMISTRY OF ANIMAL LIFE.

The existences of the two orders of animal life which we distinguish as *plant* and *animal* are almost wholly dependent one upon the other; remove plants from the earth, or change the process of their respiration and nutrition, and animals would inevitably perish. On the other hand, annihilate animal life, and soon the green aspect of Nature would be changed for one of pallid sickliness and prospective desolation.

Moreover, the one subject runs by a natural channel into the other. One of the most difficult problems presented to the naturalist for solution is that of marking the distinction between a plant and an animal, in cases where the attributes of both classes of organizations are apparently presented by the individual in question. As an illustration of what I wish to convey, I may refer to those exquisite objects the *Desmidiaceæ*, which all of my readers who are microscopists are familiar with, as examples of the variety of form attainable by the simple plant-cell. The usually accepted distinction between a plant and an animal is, that the former remains fixed to one place, unless indeed influenced by some external cause, as the ebb and flow of ocean-tides for instance; while the latter possesses an inherent power of changing its locality, and also of providing itself with food, at pleasure. Now, the *Desmidiaceæ*, were the eye alone, even when assisted by the most powerful microscope, depended upon, would exhibit a contradiction to such an axiom; for as we gaze untired upon their beautiful structure we see frequently the most active movements. Sometimes when buried in mud they will, stimulated by the light, rise to its surface; those provided with seeming tentacula will stretch them forth, as if in search of prey; or, when the water containing them is allowed to dry up, they secrete themselves in the deposit at its bottom. Now, were it not that unerring chemical proof has been given of their vegetable origin by demonstrating that *starch*, a substance never found in animals, exists in them, they would even now have been believed to be animals. Another, and in my opinion far better, distinction exists. It is this: Animals—all animals, as far as we yet know—inspire oxygen and exhale carbonic acid; while in plants, on the contrary, the reverse of this process takes place, carbonic acid being inspired, and oxygen given off.

The ultimate or simplest constituents of animals are in every respect the same as those found in plants. This is only what might, *a priori*, have been expected, for the food of animals is entirely derived, in the first instance, from the vegetable world, or rather an interchange of these ultimate constituents is constantly taking place. If, for example, we set out by supposing the existence on the earth of an animal consisting, we will say, for the sake of simplicity, of carbon, hydrogen, and oxygen; when this animal dies, the process commonly known as putrefaction sets in, which is, in other words, merely the resolution of the more complex bodies which constitute fat, muscle, etc., into carbonic acid and water; the former becomes partly dissolved in the latter, which sinks into the soil. Oxygen, hydrogen, and carbon are thus supplied to the plant through its roots, and the leaves absorb carbon and oxygen from the air. From these bodies are elaborated the lignine, starch, sugar, and other products. As corn, potatoes, or hay, we follow these substances until we find them having again become the food of animals, partaking of that form of existence from which we first traced them.

An animal, of which man is the perfect

type, may be considered as an intricate piece of apparatus, in the construction of which the labours of the engineer, optician, and chemist have been employed.

This is a retrograde method of viewing the matter, seeing that all the efforts of these men are directed to the, as near as may be, imitation of Nature; however, as an illustration, it will answer our purpose. In this machine an immense number of distinct indications are to be fulfilled. To take, for example, one set of these—It is to be able to supply itself with new material for the renovation of parts removed by attrition and other causes, and as it will be placed in such circumstances that this material will require seeking for, powers of prehension and locomotion will be essential. The machine, we premise, is to be self-conscious, but it is to possess no innate power of knowledge, all its acquaintance with external objects is to be derived from their influence on modified parts of its structure. It will next require a means of discerning the objects of the requirement just mentioned, and separating them from others not suited to the purpose. As they will, when obtained, be unfit, from their dissimilarity to the already formed structure, to unite with it, a particular part of the apparatus must be set aside for the elaboration, from this crude material, of a proper substance. As the machine is complex, having several functions to perform, it will, necessarily, from its shape, require the new material to be presented in the liquid form, as the most available and equable.

Canals will, therefore, be required to distribute it throughout all parts of the structure, and a motive power to force it through these canals be an absolute necessity.

Automata have actually been made which fulfilled many of these conditions; but it is only in Nature that the conversion of food into a nutritive fluid, and the formation therefrom of the various secretions necessary to the well-being of the animal are ever carried out. The study of animal chemistry is, from any point of view, one of the highest importance. It interests us in the food we eat, pointing out that which is most nutritious, the most easy of digestion, or the most suitable in abnormal states of the system. It calls our attention to the water which we drink, warning us of the fatal effects following from the continued use of such as contains any quantity of foreign matter. Still more are we led by its dictates to care as to the purity of the air we breathe, seeing that this is one of the great essentials to the maintenance of animal life. Furthermore, we are taught by its aid how far the use of the stimulant narcotics which a beneficent Creator has blessed us with, the tea, coffee, alcohol, etc., are productive of good, and by a knowledge of their effects on the economy, are enabled to judge what extent of their employment constitutes excess. The successful treatment of disease by medicinal agents is, in the advanced state of present science, founded upon a knowledge of the chemical action of the remedies; and one of its greatest triumphs, and one to which I shall again more particularly refer, has been the supplying to a weakened organ its deficient secretion.

You grant that the study of animal chemistry is useful; will you doubt its interest? All science, as the means of more fully appreciating the beneficence of the Creator, must ever be so.

The student of geological and palæontological science, in the territory which it is his province to explore, finds much of enthralling interest. Looking even upon a mass of bare limestone-rock, he traces it in its formation. In imagination he pictures it as receding waters cover it with a stratum of alluvial soil, and it is fitted to sustain vegetable existence. Patiently he watches it as, one by one, the giant tree-fern spreads its feathery fronds, and the tall palm shoots

from the ground its airy leaf-crowned stem. Anon, to take possession of a luxuriant vegetation, come huge and fantastic saurians, monsters equally at home on land as in the sea; these are succeeded by other and different types, until at last man, by Divine fiat, stands upon a finished world, its crowning glory.

Astronomy, as relating to a class of bodies separated from us by such inconceivable distances, and, therefore, not to be studied by any of the means which aid us in elucidating any mundane branch of knowledge, must ever possess a deep and peculiar interest.

The great sun himself, the mysterious centre of our planetary revolutions, do we ever appreciate correctly all that there is of the grand and terrible in him? Whence the source of his heat? where the powers which sustain his ponderous mass in space? what his ultimate destiny? The planets, are they all, as we know the moon to be, arid and uninhabitable deserts; or are they, like our own world, teeming with intelligent existences? Do they hold beings with feelings of love and hate, joy and sorrow, with hopes and fears, with wants to be satisfied, and desires to be gratified; or are they the residences of another almost unimaginable race of creations, the very antitheses of what the inhabitants of this earth were before the advent of humanity—ethereal beings, to whom earthly sensations, earthly passions are unknown, who communicate ideas by means of which we can have no cognizance, and who, having never fallen from the perfect state of existence in which their Creator placed them, employ it entirely to his glory? Who shall say? And the little stars, like, as our Tennyson says, "A swarm of fireflies tangled in a silver braid," shall we dare to say that they are useless? shall we, when the smallest zoophyte far down in the deep blue ocean, when the tiniest animalcule that swims its great world of a drop of water, have each its part allotted to it, so far forget ourselves as to say that any one of the bodies of space is without its object? What, if when we shall have "put off this corruptible," our emancipated spirits should fleet to one of these! Viewed as a stupendous whole, is not the entire scheme of Nature, that Cosmos which Humboldt sought to portray, even as known to us, magnificent? An enthusiastic admirer of Niagara once told me, that as he for the first time beheld the great river precipitating itself into the surging lake below, the feeling elicited from him was that of thankfulness to God for having permitted him to behold so grand a sight. It is familiarity with constantly surrounding objects which blunts our perception of their magnificence.

The attractions presented by the physica sciences are too generally known to require much comment here. Prominent among them are those afforded by heat and electricity, two agents which have been turned to the greatest account by the inventive and utilizing faculties of man, and are concerned in natural phenomena of the most stupendous character. The same all-pervading principle which placed the primary rocks of our planet in their present positions, and buried Herculaneum and Pompeii in a tomb of lava, administers to our every-day wants and comforts, or assists the chemist in the most minute analysis. The same power which projects the water in Icelandic geysers, is that which, in the elegant language of Darwin,

> "Called delighted Savery to its aid,
> Bade round the youth explosive steam aspire,
> In gathering clouds, and winged the wave with fire,
> Bade the cold streams the quick expansion stop,
> And sunk the immense of vapour to a drop.
> Pressed by the ponderous air the piston falls,
> Resistless sliding through its iron walls.
> Quick moves the balanced beam of giant birth,
> Wields its large limbs, and nodding, shakes the earth."

The same agent which manifests itself so fearfully in a thunder-storm, rending the massive oak, dismantling dwellings, and destroying life, is at the same time the great means employed by Nature for the purifica-

tion of the atmosphere, and can be made, under the guidance of man, to multiply the works of his hands, to give him a light little inferior to that of the sun, or waft warning of his hate or assurance of his love to a distant land.

I fear, reader, that you will scarcely pardon this long digression, even should my object in making it be laudable. But the fact which I wish to impress is an important one. If all these arrangements of the Creator for the well-being of man, if the world upon which He has placed him, if the sun, moon, and stars, which give him light, and if the physical laws which govern them, are all so deeply interesting, that the lives of many men have been devoted to their study, shall we not justly look for much that is interesting in man himself? If everything which has been made subservient to him is, in its construction and adaptation to its peculiar end, so absolutely perfect, that we look in vain for any flaw or error, how much more so shall we find the means employed for the maintenance of life in him.

It will naturally be inferred that in my sketch of Animal Chemistry I shall confine myself to its operations in man, and I do so for this reason:—Man is, physically speaking, the perfection of the animal type, all the vital processes are carried in him to their highest point, and, therefore, in him we may best look for illustration of any or all of them.

To weary no longer with a preface, let me at once proceed to my subject.

As anything like a complete and detailed account of the chemical processes employed in the human organization, or even a cursory sketch of all of them, could not possibly be condensed into a necessarily limited essay, I shall confine myself to the consideration of the following points:—

1st. The food eaten by man, or, in other words, the material which is afterwards to be converted into new bone, muscle, fat, etc. 2nd. The means by which this raw material is converted into a fluid, which, traversing the entire body, is brought into contact with the parts which need—and all parts are in constant need—of renovation; and, finally, we shall consider the chemical changes which take place in the body as consequences of the act of respiration.

Why, then, in the first place, is food necessary, and of what does it consist? Our bodies are formed of carbon, hydrogen, oxygen, and nitrogen, in certain fixed proportions, constituting muscle, cartilage, bone, the substance of the brain, and other tissues. Now suppose that it were possible that all the operations of vitality should suddenly be stopped, that we should cease to think, to move, to speak, that the blood should no longer flow through the veins and arteries, that we, in other words, were for a time dead. No food would then be required, for there would be no waste of matter, and consequently no need of a fresh supply. But on the resumption of vitality, every act or thought, every glance of the eye, the movement of the body in walking, the motion of the hands in working, would all produce a certain loss of matter which requires renewal; how the loss takes place we shall afterwards see. The food of animals is divided into two great divisions, that which does not contain nitrogen, and that which does. In the first category are starch, sugar, gum, and also alcohol, which does not occur in Nature, but is artificially prepared from sugar. These non-nitrogenous substances are, it will be observed, with this exception, all derived from the vegetable world directly. There are one or two others which are obtained indirectly from the same source through the medium of animals, the principal of these is *fat*. In the other class, that is of bodies which do contain nitrogen, are *albumen*, *fibrin*, *gluten*, and *casein*. It will be well to briefly enumerate the sources of these bodies.

Starch is found in the potato, in wheaten flour—in fact, in all the cereal grains, and

arrowroot, sago, tapioca, etc., consist entirely of it. The principal source of sugar is the well-known West India cane, but it is also obtained from the beet, mangold wurzel, parsnip, etc. Gum, although existing as an uncombined product in several plants, cannot be said to be derived from them to form a portion of human food. We obtain it principally from the flour of the grains which we use for bread, and a part of the starch is, in the process of baking, converted into this substance.

Alcohol, as is well known, is a product of the fermentation of sugar, and exists in several forms; but whether as beer, wine, whisky, or brandy, its action in the animal economy is in each case the same.

Fat or oil occurs in the seeds and fruits of many plants, as the almond, olive, maize, etc., which are employed as food.

The composition of all the above enumerated substances may, for the sake of simplicity, be considered as identical: they all consist of carbon, hydrogen, and oxygen, and do not contain nitrogen. So much then for the sources of the first class; let us now consider those of the second. Albumen exists in the white of eggs, and in the serum of blood, and constitutes the great mass of most animal tissues. Fibrin is found in the solid portion of blood, or that portion of the fluid which separates when it is allowed to stand for some time. It also constitutes the principal portion of muscular fibre. Gluten, which may be looked upon as vegetable fibrin, is that substance which, when flour is washed under a stream of water, remains as an adhesive mass. This latter class of bodies contains, in addition to the carbon, oxygen, and hydrogen, which are found in the first, *nitrogen*. I must not omit to mention gelatine, which is contained in the skin and many membranes. Glue and isinglass are familiar examples of gelatine.

The two great objects which have to be fulfilled in the animal economy, that at present come under our notice, are the production of a certain degree of heat, and the renewal of the matter which is wasted or consumed by the various acts of vitality. For as in a steam-engine motion is produced at the expense of part of the material of the machine lost by friction, so, in the animal body, there is, as I before stated, never any motion unaccompanied by a loss of matter commensurate with the amount of that motion. For example, there are in the human body more than four hundred distinct muscles, each with its own peculiar duty to perform. Now, in the apparently simple act of respiration there are employed more than one fourth of this number; and when it is recollected that the lungs are inflated nearly a thousand times in each hour, and that, at each inflation, the elastic force exerted by these muscles is equal to about five hundred pounds, we can form some idea of the amount of this waste in the entire body. The wasting action consists in the oxidation of the carbon and hydrogen of the tissues, and the new products thus formed, water and carbonic acid are excreted from the system. Nor is the action itself useless. The chemical combination of two bodies never takes place without the liberation of heat, and in this case there is no exception to the rule, as this is the source of all animal heat.

Let us clearly understand:—The animal tissues are composed of carbon and hydrogen. Oxygen, one of the constituents of the air we breathe, is inspired; uniting with the carbon it forms carbonic acid, with the hydrogen, water, both of these compounds returning to the air, and serving those important ends which can only be distinctly considered in studying the chemistry of vegetation. The result of the combination is heat.

Both of these actions can be artificially produced with the same result. Of one we have constantly present illustrations in a common fire, or the flame of a gas or oil-lamp, or of a candle. For, in the gas, oil,

tallow, or wax, which constitutes the combustible material of these sources of heat and light we have the representative of part of the waste matter of the body, the carbon.

It is well known that none of these will burn when deprived of air; there must be, then, something in the air essential to combustion—this something is oxygen. In the act of combustion it combines with the carbon, and carbonic acid—the gas the ill effects of which, in an ill-ventilated, strongly-lighted room, are so familiar—is produced.

Of the other case, viz., the union of oxygen with hydrogen, an example is afforded by a contrivance which was much used as a means of producing instantaneous light before the introduction of phosphoric matches, and which went by the name of Dobereiner's Lamp. It consisted of a glass vessel in which hydrogen was generated, and which was furnished with a jet, through which the gas was, by its own pressure, forced. In a little cup opposite this jet was contained a piece of finely-divided platinum, a metal which possesses the peculiar property of concentrating on its surface large quantities of oxygen. When the jet of hydrogen impinged upon the platinum it united with the oxygen, and sufficient heat was evolved to make the metal red-hot, and, finally, to inflame the gas.

In both of the above cases we have heat produced; and in one water, and in the other carbonic acid, evolved. The use of animal heat we shall afterwards have to consider. To return to our subject: The necessity of food being admitted, and its constituents glanced at, let us now consider the means by which it is made to supply the waste which we have been speaking about.

If the aliment be presented in the liquid form, no previous preparation is requisite; but if, as is generally the case, it is solid, it requires to be finely divided, so as to present the largest possible amount of surface. The reason of this we shall presently see. This is effected by what is called the masticatory process, in which the teeth, tongue, and a set of secreting organs, called the salivary glands, come into play. By the agency of the two former the minute state of division is produced to perfection, and the food in this condition becomes mixed with the secretion of the salivary glands, and passes from the mouth, in which this operation has taken place, into the stomach. It will be well, before going any further, to dwell slightly upon the nature of the salivary fluid.

It is slightly heavier than water, and contains in every thousand parts from seven to twelve parts of solid matter. Part of this consists of mucus and fatty matter, and part of a peculiar body called *ptyalin*, which very closely resembles the diastase of malt. The diastase of malt possesses the property of transforming starch into gum and finally into sugar, and it is this fact which has been taken advantage of in the production of all fermented malt liquors.

Now, this property is also possessed by ptyalin, and we must remember this fact when we come to speak of its application. The saliva is for the rest a thickish fluid, having an alkaline reaction—circumstances which render its complete incorporation with the food during the masticatory process much more easily effected than if the secretion consisted of water alone.

The food thus perfectly mixed with saliva having arrived at the stomach, we must now see what changes are there made in it. Lining the internal portion of the stomach is a soft membrane, beneath which and opening into which is an immense number of little tubes running parallel one to the other. These tubes secrete the *gastric juice*, which is the natural solvent of the food. If any one operation of those which come under the head of animal chemistry be more interesting than another, it is that which we are about to consider; and in chemical constitution there is no secretion which may be studied with more advantage than the gastric juice.

The gastric juice is a yellowish fluid, clear and transparent, very little heavier than water. Its most remarkable sensible quality is its acidity, which is said by some chemists to be caused by lactic, by others by hydrochloric acid, and this is a point still disputed. Next to the fact of its acidity, the most important point in connection with this fluid is its solid organic constituent. This has received the name of *pepsin*, from a Greek word signifying to cook. It is the active principle of the fluid; in its absence the acid, be it what it may, would fail to effect solution of the food. There are technical hindrances to the obtaining of pepsin in a perfectly pure state, but it has been procured as a moist glutinous mass by the evaporation of its solution, and in this form examined. Pepsin *alone* does not possess any more power of digestion than the acids of the gastric juice would do without pepsin; but on the presence of these acids solution of the alimentary matter is immediately effected. Its action, indeed, closely resembles that of the yeast of beer, which has the power of inducing fermentation in a solution of sugar; for we see that pepsin, though incapable itself of dissolving substances, can by its presence determine their solution in the acid. This may be proved by placing in a weak solution of hydrochloric acid a portion of muscle or some albumen. No action will take place, even though they should remain in continued contact; but on the introduction of a piece of the mucous membrane of a stomach, or of pepsin itself, the digestive process immediately begins. Now, we have before seen that all the starchy or non-nitrogenous constituents of the food are, while in the mouth, partially converted by the saliva into sugar. It has been experimentally proved that pepsin possesses the property of further converting this sugar into lactic acid. It is a process which can as easily be performed in the laboratory as in the stomach, and thus great weight is given to the hypothesis that the acidity of the gastric juice is due to this fluid.

The most interesting fact in connection with the subject is, that the gastric fluid of the ruminant animals having been found to be identical with that of the human species, the pepsin is from them obtained in large quantities; and no small boon has it proved to those who, having unfortunately but a limited quantity of the secretion themselves, suffer in consequence from indigestion.

The gastric fluid is never present in the stomach, unless that organ is stimulated by the presence of food—a fact which at once makes null and void the supposition that it was by its corrosive action on the coats of the stomach that the sensation of acute hunger is produced. This is simply absurd when it is recollected that, together with what has been already stated, an action like this cannot be exerted upon a living tissue.

The most important accessory to the digestive process is moderate heat. When the temperature of the stomach is considerably lowered, it ceases entirely; and when raised above a certain point is equally stopped, as under the latter condition the pepsin itself becomes decomposed.

The nitrogenous constituents of the food, the fibrin, gluten, albumen, etc., are, while we are discoursing of the gastric juice, being reduced by it to a pulpy fluid, the starch has long since been converted into sugar, and we have only to get the fatty matters, well known not to be the most digestible, into something approaching to their condition, and we shall be then ready to follow them all in the further part which they have to play. Gastric juice has no chemical action upon fat, and the only change which these bodies at present undergo is to become finely divided by the motion of the stomach. But how is it that we know all this? how have we arrived at the fact that food really undergoes these changes? how is it that human gastric juice has been obtained?

In the year 1825, a young Canadian, named Alexis St. Martin, received, while in the employment of the American Fur Company, by the single discharge of a musket, a series of wounds, which, had they all remained unhealed, and the man had continued to live, as he did for some years afterwards, have rendered him an anatomical curiosity. With one exception, they did all heal, and this exception causes Alexis St. Martin to be introduced into this paper. To the advantage of physiology and to his own personal inconvenience, there remained a good-sized opening into his stomach; and as he happened to fall into the hands of a physician with an inquiring mind, no opportunity was let slip of ascertaining all the phenomena of gastric digestion. Indeed, considering all the experiments that have been made upon his stomach, St. Martin himself must either take a very deep interest in the cause of science, or be naturally of a very submissive and patient disposition. To have pieces of hard salt meat tied to strings, and dropped into his interior for a specified time, after which they were taken out and examined; or to be put into a passion in order to have the effect of mental excitement upon digestion noted, have been among the least of his grievances. Water, now hot, now cold, has been injected into the orifice; he has been nauseated by fat, kept in a state of semi-starvation for hours, and the effects of an entire pharmacopœia of drugs tried upon him. Strange to say, he was alive not long since, and in perfect health.

The alimentary matter, now reduced to a uniformly pulpy condition, and known as chyme, passes from the lower orifice of the stomach into the intestine, where it becomes intimately mixed with two other secretions: one from the liver, called bile; the other from the pancreas, called the pancreatic juice. What the precise objects of these secretions are has not yet been decided, but it is certain that the fatty matters, before meeting with them, have as yet been acted on by mere mechanical power, and that afterwards they become perfectly suspended in, if not inseparable from, the rest of the fluid, which has now very much the appearance of milk. It is thought, also, that by the alkaline action of the bile any tendency to putrefactive fermentation of the chyme is prevented.

In passing slowly through the intestinal canal, part of the fluid now called *chyle* is absorbed by a set of extremely minute tubes, and finally conveyed by a long tube, called the thoracic duct, to a vein in the neck, and from thence directly to the heart.

The circulatory process, even as far as I shall describe it, would, if fully treated of, occupy many papers such as this; it would comprehend a crowd of details both anatomical and physiological, and you would see at every step the working of that infinite power which has provided in our structure for great necessities and trivial demands with equal care.

It is, however, only with its chemistry we have to do.

I must premise, however, that the two organs essentially concerned, or, to speak chemically, the apparatus employed in this action, are the heart and lungs. It will suffice for our purpose if we consider the former of these to be, to all intents and purposes, a force-pump in connection with two sets of pipes; one set are called arteries, the other veins. The heart has also connection with the lungs, which consist of an immense mass of blood-vessels interwoven with minute air-cells, in such a manner that each air-cell is continuous with a blood-vessel. The blood-vessels are continuations of the artery which brings the blood from the heart, and the air-cells are prolongations of the trachea, by which air is supplied from the external atmosphere. Let us now see what is the object of this arrangement. These two sets of tubes contain about five

and twenty pounds of a fluid which we know as blood, and which in reality consists of those substances which we before considered as essential to the maintenance of life in a state of perfect preparation for assimilation by the body. I may quote the following illustration:—

"The body is like a city intersected by a vast network of canals, such as Venice or Amsterdam; the canals are laden with barges, which carry to each house the meat, vegetables, and groceries needed for daily use; and while the food is thus presented at each door, the canal receives the sewage of the houses. One house will take one kind of meat, and another house another kind, while a third will let the meat pass, and take only vegetables; but, as the original stock of food was limited, it is obvious that the demands of each house necessarily affect the supplies of the other. This is what occurs in nutrition. The muscles demand one set of principles, the nerves a second, the bones a third, and each will draw from the blood those which it needs, allowing the others for which it has no need to pass on."

But you say, Where did this fluid come from? Do you not remember the thoracic duct, through which the chyle was poured into the subclavian vein? That thoracic duct was the end of the digestive system, and the vein the beginning of the circulatory system, and the fluid which we studied during its elaboration has now become a portion of the blood. I said, at the outset of my subject, that the two great ends to be fulfilled were the supply of lost matter and the maintenance of heat. We have seen how the former object is effected, let us now proceed to the latter. The air which we breathe, and which is so universally distributed around our planet, is composed, in every one hundred volumes, of seventy-nine volumes of oxygen. The oxygen is the essential agent, the nitrogen merely serving to dilute it and modify its too energetic action. In respiration the air is taken through the trachea into the air-cells of the lungs, and there comes into contact with the blood, which, by travelling over the entire body, and having given up a portion of its life-supporting matter to it, has become unfit to any longer sustain existence. Here it absorbs oxygen, is conveyed to the heart, and from thence to the entire system, again to nourish and support it.

I said before, that every action of the body produced a corresponding waste of matter, and that this waste consisted of two substances, carbon and hydrogen. I showed you, also, that oxygen united with these bodies to form other compounds, and you will recollect that its compound with carbon was carbonic acid. It is this compound which we have now alone to consider. When the inspired oxygen comes into contact with the blood, and therefore with the finely-divided carbon, which, in the form of waste matter, it contains, carbonic acid is the result. Now the carbonic acid (which is in the gaseous state) dissolves in the blood, and when that fluid comes to the lungs, the air, which it there meets with, displaces it, is absorbed in its stead, and the deleterious gas is given to the atmosphere.

Thus one continued process is constantly taking place. Oxygen is absorbed by the blood, carbonic acid exhaled, the aerated blood passing to the heart is forced over the entire body, the largest arteries and the most microscopic capillaries each receiving a proportionate share. Its office being fulfilled, the veins return it dark and sluggish to the heart, from whence, once more, the lungs receiving it, send it bright and vermillion coloured to carry out its mission of life.

This, then, is one great source of animal heat, and it may be well to notice that the way in which it is produced—being carried on over such an immense extent of arterial surface, immense indeed, when we recollect

that the network of arteries and air-cells which compose the lungs alone, would, if extended, cover a space of 2642 square feet—is that by which it can best be equalized.

Let us pause, too, in admiration of the beneficent schemes by which an equable temperature is maintained under all circumstances. "A thermometer," says a writer in *Blackwood's Magazine*, "stands at the same temperature when placed under the tongue of an Arctic voyager, or of a soldier before the walls of Delhi." When we consider how many of our fellow-men are obliged, not only by difference of climate, but by the exigencies of their business, to spend the greater part of their lives in heated atmospheres, like those of glass-works and iron-foundries, where the temperature of the air is frequently four times greater than its normal condition in this country, then, and only then, we see what is really the cause for thankfulness.

We may glance, too, for a moment, even though it be unconnected directly with the subject, at the amount of real hard work which these organs, these frail, delicate, ah! how often too delicate, too frail lungs, have to perform.

In the course of a single year they will have contracted and dilated about nine million times, 100,000 cubic feet of air will have been inhaled, and more than 3500 tons of blood will have been aerated; and all this with such freedom of effort on our part, freedom even from consciousness, that we never can appreciate the value of the boon until we are deprived of it.

Thus have I, perhaps too rapidly, sketched an outline of animal chemistry as relating to but one phase of creation, and but to one series of operations in that phase. You may judge, then, how extended is the theme, when every organ in our bodies is the seat of processes as complex and as well worthy of study; and when you remember that although there are many animals lower in the creative scale, who possess organisms somewhat like our own, there are yet many more in which they vastly differ, and in which, as a consequence, the chemical operations are infinitely varied.

What chemistry, best beloved of sciences, may yet accomplish I know not. For her was birth in Egypt not in vain; not in vain for her the else fruitless toilings of Arab sages and English monks; not vainly for her did her Davy labour, her Priestly die in a foreign land, and her Lavoisier fall victim to the blind ire of a sanguinary mob. It is not for nothing that the entire social system acknowledges her influence; that medicine, agriculture, and the arts bow before her dictates and employ her power. Chemistry has ever been the friend of man; from his very infancy she ministers to his wants; by her irrevocable laws his harvests ripen, and his earth is clothed with verdure; by her aid he obtains from the crude products of earth's dark bosom the much enduring metal which has paved his way to civilization; and often on the bed of sickness baleful fever owns her magic touch, and spares his victim. And how know I whether when the "silver cord is loosed," and the "golden bowl is broken," and the body which I now possess has been resolved into its ultimate constituents, my Creator may not employ his first-called handmaid to knit around the light-winged Psyche its new and more enduring habitation?

HARRY NAPIER DRAPER, F.C.S.

Dublin.

THE TRANSIT OF MERCURY

On the 12th was observed under most unfavourable circumstances in England, and, in the few cases where pretty good views were obtained, the phenomena were such only as are common to occurrences of the kind; the egress of the planet being marked by no novel features.

THE ART OF DYEING PERMAMENT COLOURS.

It appears almost singular that surrounded as we English are with such numerous productions of artistic and manufacturing skill, all of them more or less contributing to the comfort and convenience of our civilized life, so few should care to inquire into the methods of their production, though such inquiry would prove generally interesting, and usually result in a juster and higher appreciation of their intrinsic worth. How few ladies, for instance, know anything of the substances *from* which, and the process *by* which, are produced the brilliant hues of their velvets and satins, or the still more complicated means employed in the art of printing the muslins and calicoes which form the morning costume of so many, and the daily dresses of our female servants. Yet in this latter art especially there are employed not only most curious and costly machines, but a variety of materials and manipulations greater, perhaps, than in any other. The most delicate chemical actions are called into play, and not only the skill of the machinist and chemist, but also that of the designer and engraver are brought into requisition to produce the variety of patterns and colours in daily use.

The art of dyeing is one of great antiquity. The earliest notice of it is probably to be found in the Scriptures (Exodus xxvi. 14), where one of the coverings of the tabernacle is commanded to be of "rams' skins, *dyed red*;" and we have ocular testimony, in the bandages of Egyptian mummies, that the art of giving this colour to linen was known at a period not later than the one just mentioned. The purple cloths of Tyre had also a worldwide celebrity. It is said that their colour (which was probably what we call crimson), being obtained from a shell-fish by a putrefactive process, communicated permanently to the cloths what Shakspeare calls—

> "A very ancient and fish-like smell."

But they were nevertheless employed for the magnificent robes of emperors and kings, and even for the regal dresses of their queens, their great beauty and enormous price acting possibly as antidotes to their unpleasant odour. "Pride," says an old proverb, "feels no pain," and this is at least as likely to be true of the olfactory as of any other set of nerves.

The materials employed by our modern dyers, are, for the most part, less offensive, and when any are used which might communicate an unpleasant odour to the fabric, the processes are so arranged that this becomes imperceptible in the finished goods. Dye-stuffs, as they are technically called, are for the most part the produce of the vegetable kingdom, cochineal being almost the only animal substance made use of as a source of colour. Some chemical products from the mineral kingdom are also employed, of which we may speak more freely in a future paper.

There is a wide difference between dyeing and staining; the former producing what are called *fast colours*, and the latter only such as are altered or partially, if not entirely, effaced by washing. Port wine, coffee, tea, and many other fluids will produce a *stain* upon silk, cotton, or woollen; but this is not, strictly speaking, a dye, as the colour may be readily removed without employing chemical agencies not in common use. Something in these instances is wanting to attach the colour firmly to the stuff by causing them to combine chemically, and thus resist the usual solvents employed in domestic operations.

It is here that the resources of the dyer are called into action. As very few colouring matters will combine directly with the material to be dyed, recourse is had to other substances that have an affinity for both, and by the application of these the dye is fixed, or rendered permanent. These substances are termed mordants, and as many of them not only fix, but also alter the colour of the dyeing material, the dyer is thus enabled to produce various tints, and even entirely different colours from the same material. In the composition and application of these mordants there is room for the employment of much practical skill, as well as of chemical knowledge, without which no one can become a successful practitioner in the art. A detailed account of the numerous materials and processes made use of would be foreign to our present object, but some few examples may not be without interest. The well-known substance called indigo is the produce of a plant, and in its original state is *green*, and soluble in water. By the absorption of oxygen from the atmosphere it becomes *blue*, and being then insoluble cannot be made to combine with cotton or other textile material. To overcome this difficulty the dyer mixes it with certain matters, which, by depriving it of its oxygen, restore it to a soluble state, and into this green liquid dips the substance to be dyed. When saturated it is withdrawn, and either exposed to the air or plunged into a fluid which, by restoring the oxygen, restores at the same time the beautiful blue colour, and this, being now insoluble, is capable of resisting the application of soap and water, or, indeed, of any substance ordinarily used as a detergent. Various depths of colour are, of course, readily produced by mixtures containing different proportions of indigo. Though this substance in its blue state is not, as has been said, soluble in water, it may be dissolved, without losing its colour, in sulphuric acid (oil of vitriol), and this solution, when partly neutralized by an alkali, and sufficiently diluted, is capable of combination with an animal or vegetable material, as silk or cotton. If the former be merely dipped into the liquid it is at once dyed, and so strong is the affinity of the silk for the colour, that, if the quantity of it be sufficient, the bath is left nearly colourless. By immersing smaller portions in succession, every shade may thus be produced, from the deepest Saxony blue to a tint scarcely different from white. In this process it may be remarked that it is the sulphuric acid which acts as the mordant, and it is the same substance that is employed in the former process to restore the oxygen to the indigo, rendered green and soluble by being deprived of it.

Several of the vegetable substances used in dyeing contain more than one kind of colouring matter. Thus madder, which is the root of a plant of the family *Rubiaceæ*, and one of the most important of our modern dye-stuffs, yields both a dull brown and a fine red colour, capable of being separately extracted, or of being employed in combination. It is chiefly, however, for the latter that the root is valuable, and the extraction of this in its purity requires some very complicated and beautiful processes, the result of which is the brilliant colour known as Turkey red. Safflower or carthemus also contains both a yellow and a red colour; the former of which is almost useless, whilst the latter produces delicate pinks. It is this substance which is employed in the manufacture of the rouge sometimes made use of by ladies as a cosmetic. When pure this preparation is quite harmless to the skin, but it is too often adulterated with matter of an injurious character, and ought, therefore, always to be avoided.

No material has yet been found that will by itself furnish a green dye of any permanence, and consequently this colour can only be produced by a suitable mixture of yellow and blue, which are usually applied sepa-

rately. This fact seems somewhat remarkable when we consider the prevalence of green in the vegetable kingdom, though it may be observed that it exists chiefly in the leaves, whilst the portions used by dyers are more commonly the root, bark, or wood. A method of extracting and fixing a pure green from the leaves of any of our European vegetables would be a valuable discovery, and may yet possiblybe arrived at by some of our skilful chemists.

The recently produced and now fashionable colours called Mauve and Magenta, afford perhaps the most striking instance of the application of chemical science to the art under notice. Many of our readers may be surprised to learn that these truly beautiful tints are all produced from coal; not, indeed, by one direct process, but by a series of operations involving what are called by chemists "substitutions." In the manufacture of gas from coal, there is produced a a large quantity of tar, and from this is made a liquid termed aniline. This latter derives its name from "anil," the Portuguese word for indigo, and was so called on its first discovery, from its being procured from that substance. Not many years ago the possession of a few ounces of this liquid was a rare and notable circumstance in the laboratory of a chemist; but an intimate knowledge of its constituents, and those of coal tar, led to its production from the latter material, and subsequently from it to that of the colours just named. This fluid, which is now manufactured in large quantities, is the source of these dyes, and it is a curious fact that one of the agents employed in its conversion into them is the chloride of lime, so largely employed in *bleaching* and as a disinfectant. From recent experiments it appears not unlikely that other and even more beautiful colours will be produced from the same source, the chief difficulty at present being to do this at sufficiently small cost to render the operation profitable.

It has been said that the man who makes two blades of grass grow where previously only one was the produce, is a benefactor to society, and though Mauve and Magenta ribbons may not be as necessary to us as grass and corn, we may yet give no small praise to him who, from such a common and inelegant substance as our ordinary fuel, has produced these really beautiful and ornamental colours. No one need now apply to the scientific investigations of the chemist the often sneeringly asked question, "*Cui bono?*" and certainly no lady of taste will ever think of propounding such a query.

Croydon. BENJAMIN ABBOTT.

METEOROLOGY OF DECEMBER.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Mean elastic force o vapour, or the pressure due to the wate contained in the air.	Mean pressure of dry air, or the pressure due to the gases of the air.	Mean weight vapour cubic of air.	Mean degree of humidity 100 = compl saturation.	Mean quantity of water in a vertical column of the atmosphere.	W of a c of air.
	Of an inch.	Inches.	Grs.		Inches.	Grs.
1848	0·253	29·540	2·9	0·86	3·5	545
1849	0·218	29·599	2·8	0·96	3·0	550
1850	0·233	29·625	2·7	0·91	3·2	551
1851	0·242	29·869	2·8	0·89	3·4	553
1852	0·269	29·246	3·1	0·87	3·7	538
1853	0·184	29·637	3·2	0·85	2·5	556
1854	0·233	29·444	2·7	0·86	3·3	546
1855	0·198	29·504	2·4	0·88	2·7	552
1856	0·208	29·303	2·4	0·87	2·9	549
1857	0·257	29·814	3·0	0·88	3·5	553
1858	0·210	29·498	2·4	0·86	2·9	552
1859	0·158	29·506	1·8	0·80	2·2	556
1860	0·166	29·359	2·0	0·82	2·3	553
Mean	0·218	29·546	2·6	0·87	3·0	550

The mean elastic force of vapour, *i. e.*, the pressure of the barometer due to the water contained in the air, is for December of the past thirteen years 0·218 of an inch; ranging between 0·158 of an inch in 1859, and 0·269 of an inch in 1852—a difference of 0·111 of an inch.

The mean pressure of dry air, or the pressure due to the gases of the atmosphere at the height of 174 feet above the mean sea-level, for December of the last thirteen years, is 29·546 inches; ranging be-

tween 29·246 inches in 1852, and 29·869 inches in 1851 —a difference of 0·623 of an inch.

The mean weight of vapour in a cubic foot of air for December, during the last thirteen years, is 2·6 grains; ranging between 1·8 grains in 1859, and 3·2 grains in 1858—a difference of 1·4 grains.

The mean degree of humidity (complete saturation being represented by 1·00) for December, during the last thirteen years, is 0·87°; ranging between 0·80° in 1859, and 0·96° in 1849—a difference of 0·16°.

The whole amount of water in a vertical column of the atmosphere for December during the past thirteen years is 3 inches; ranging between 2·2 inches in 1859, and 3·7 inches in 1852—a difference of 1·5 inches (or 1½ inches).

The mean weight of a cubic foot of air for December, during the past thirteen years, is 550 grains; ranging between 538 grains in 1852, and 556 grains in 1853 and 1859—a difference of 18 grains.

E. J. Lowe.

ASTRONOMICAL OBSERVATIONS FOR DECEMBER, 1861.

The Sun is in the constellation of Sagittarius until the 21st, when he passes into Capricornus. He rises in London on the 1st at 7h. 46m., on the 10th at 7h. 57m., on the 20th at 8h. 5m., and on the 30th at 8h. 9m.; setting in London on the 1st at 3h. 52m., on the 10th at 3h. 49m., on the 20th at 3h. 51m., and on the 30th at 3h. 57m.

He rises at Dublin on the 3rd at 7h. 59m., and on the 23rd at 8h. 19m.; setting at Dublin on the 4th at 3h. 40m., and on the 24th at 3h. 41m.

He rises at Edinburgh on the 1st at 8h. 9m., on the 9th at 8h. 21m., on the 14th at 8h. 29m., and on the 22nd at 8h. 33m.; setting at Edinburgh on the 2nd at 3h. 28m., on the 10th at 3h. 23m., on the 15th at 8h. 22m., and on the 23rd at 3h. 25m.

Day breaks in London on the 1st at 5h. 41m., and on the 29th at 6h. 2m.

Twilight ends in London on the 10th at 5h. 55m., and on the 30th at 6h. 3m.

Day breaks at Dublin on the 3rd at 5h. 53m., and at Edinburgh on the 15th at 6h. 22m.

Twilight ends at Edinburgh on the 1st at 5h. 38m., and at Dublin on the 20th at 5h. 31m.

Length of day at London on the 1st, 8h. 6m.; at Edinburgh on the 2nd, 7h. 15m.; and at Dublin on the 3rd, 7h. 48m.

The Sun is on the meridian in London on the 2nd at 11h. 49m. 42s., on the 17th at 11h. 56m. 28s., and on the 27th at 12h. 1m. 26s.

The equation of time is on the 2nd, 10m. 18s., on the 17th, 3m. 32s., addative, and on the 27th, 1m. 22s., subtractive.

The Moon is new on the 2nd at 2h. 17m. a.m.

Full Moon on the 17th at 8h. 8m. a.m.

She is at her greatest distance from the Earth on the 13th. and at her least distance on the 29th.

There will be a partial eclipse of the Moon on the morning of the 17th, the eclipse commencing at 7h. 27m., and ending at 9h. 9m. As the Moon sets at 8h. 10m., she will be below the horizon before the centre of the eclipse. Magnitude of the eclipse (the Moon's diameter equalling 10) is somewhat less than 2.

Mercury is in the constellation of Libra at the commencement of the month, and in that of Sagittarius at its close. He is badly situated for observation. His diameter is 6″ on the 1st, and 4½″ on the 30th. He rises on the 1st at 5h. 45m. a.m., on the 16th at 6h. 48m., and on the 26th at 7h. 30m. p.m.; setting on the 1st at 11h. 22m. a.m., on the 16th at 11h. 0m., and on the 26th at 10h. 35m.

Venus is in Capricornus at the beginning, and in Aquarius at the end of the month. Her diameter is on the 1st 21¼″, and on the 26th, 27½″. She is a brilliant and a conspicuous object, remaining visible for four hours after sunset. She rises on the 1st at 11h. 22m. a.m., on the 16th at 11h. 0m., and on the 26th at 10h. 35m. a.m.; setting on the 1st at 7h. 5m. p.m., and on the 26th at 8h. 2m. p.m.

Mars is in the constellation of Libra at commencement of the month, and on the borders of Scorpio at its close. He is a faint object, his diameter being only 3¾″ on the 1st, and 4″ on the 25th. He rises on the 1st at 4h. 38m. a.m., and on the 26th at 4h. 35m. a.m.; setting on the 1st at 2h. 31m. p.m., and on the 26th at 1h. 29m. p.m.

Jupiter is a most conspicuous object in the constellation of Virgo throughout the month. His diameter is on the 1st, 33″, and on the 26th, 35½″. He rises on the 1st at 12h. 44m. a.m., and on the 26th at 11h. 15m. p.m.; setting on the 1st at 1h. 20m. p.m., and on the 26th at 11h. 46m. a.m.

Saturn is situated on the borders of Leo and Virgo throughout the month, rising on the 1st at 12h. 26m. a.m., and on the 26th at 10h. 47m. p.m.; setting on the 1st at 1h. 20m. p.m., and on the 26th at 11h. 45m. a.m.

Uranus is still in the constellation of Taurus, rising on the 1st at 4h. 1m. p.m., and on the 26th at 2h. 18m. p.m.; setting on the 1st at 8h. 23m. p.m., and on the 26th at 6h. 40m. p m.

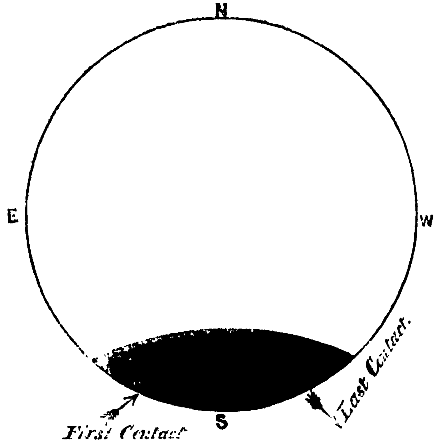
Eclipses of Jupiter's Satellites.—On the 2nd at 2h. 25m. 18s. a.m., 3rd moon reappears. On the 21st, at 2h. 29m. 57s. a.m., 1st moon disappears. On the 22nd, at 2h. 23m. 40s. a.m., 4th moon disappears. On the 26th, at 12h. 15m. 18s. a.m., 2nd moon disappears.

Occultations of Stars by the Moon.—On the 24th, ε Leonis (5th magnitude) disappears at 1h. 22m. a.m., and reappears at 2h. 28m. a.m.

The variable star Algol reaches its period of least light in the evening, on the 2nd at 7h. 11m., on the 19th at 12h. 6m., on the 22nd at 8h. 55m., and on the 25th at 5h. 44m.

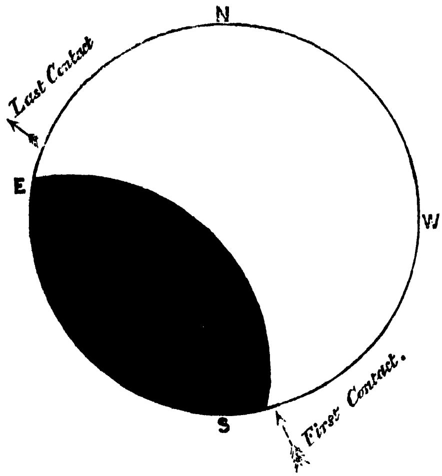
Stars on the Meridian.—On the 2nd α Andromedæ souths at 7h. 14m. 51s. p.m. On the 2nd Aldebaran souths at 11h. 40m. 54s. p.m. On the 2nd Sirius souths at 1h. 55m. 31s. a.m. On the 4th α Arietis souths at 9h. 4m. 48s. p.m. On the 5th α Ceti souths at 9h. 56m. 24s. p.m. On the 7th

Pleiades souths at 10h. 32m. 28s. p.m. On the 11th Capella souths at 11h. 48m. 54s. p.m. On the 14th Rigel souths at 11h. 33m. 40s. p.m. On the 17th Aldebaran souths at 10h. 41m. 55s. p.m. On the 17th



Lunar Eclipse at Greenwich on December 17th.

Sirius souths at 12h. 56m. 33s. a.m. On the 20th β Tauri souths at 11h. 19m. 33s. p.m. On the 23rd α Orionis souths at 11h. 37m. 50s. p.m. On the 31st



Solar Eclipse at Greenwich on December 31st.

Aldebaran souths at 9h. 46m. 52s. p.m. On the 31st Sirius souths at 11h. 57m. 34s. p.m.

There will be a total eclipse of the Sun on the 31st, visible as a partial eclipse in England. The line of totality or central shadow passes over the Carribean Sea, the Island of Trinidad, and the North Atlantic Ocean; it enters the west coast of Africa near Cape Verd; traverses the great desert of Sahara, Tripoli, and the Mediterranean Sea. The eclipse is lost in sunset immediately before reaching the Morea. At London nearly half the sun's diameter will be obscured by the Moon's shadow. It begins at 1h. 51m. p.m., reaches its greatest phase at 2h. 53m., and ends at 3h. 52m. p.m.

Magnitude of the eclipse (the sun's diameter = 1·000):—At Greenwich, 0·446; at Cambridge, 0·456; at Oxford, 0·449; at Liverpool, 0·410; at Dublin, 0·380; at Edinburgh, 0·374.

The eclipse begins at Oxford six minutes earlier than in London; in Liverpool and Edinburgh a quarter of an hour earlier; and in Dublin half an hour earlier.

E. J. Lowe.

THE MICROSCOPIC OBSERVER. DECEMBER.

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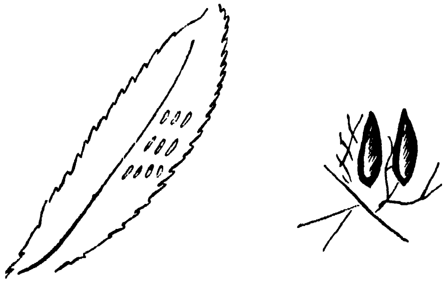
Notes on the Fungi of the Past Autumn.—I venture to suggest to those collectors of Fungi who read Recreative Science, that a record of their discoveries during the last two months, when these remarkable productions come out in their gayest attire, will be of great interest and some value. I believe, upon the whole, the season has been a favourable one for the growth and development of species, especially of the *Agaricini*; and I know that the number of collectors has been notably increased of late; several fair Nature-observers of my acquaintance have commenced the agreeable pastime of painting the forms they meet with. And as we are not Hindoos to believe that those who eat mushrooms, whether springing from the ground, or growing upon a tree, equal in guilt the slayers of Brahmen, I make no doubt that the number of species proved to be edible has been added to since Dr. Badham's "Esculent Fungi" led the way towards a better apprec'ation of their good qualities. I have no new species or great rarities to bring forward myself, though I have had the gratification of seeing at least five thousand specimens of the large, fleshy, Club-of-Hercules Clavaria (*C. pistillaris*, Linn.) congregated in a small copse. This being a new locality for this very local species, I would like it to be noted as Broadwas Brakes, near Worcester. To my knowledge it has been persistent in its habitation for seven years. Other observers have, however, seen greater rarities than this. An ardent cryptogamist, who will, I trust, when he reads this, send a list of his findings, wrote to me the other day relating the discovery of *Hydnum carophyllea*, which has been found but very seldom in this country.

I have been asked more than once of late what fossil fungi have been found and described, and as the question is one of much interest, I should like to place the following on record. I *believe*, at present, no others have been determined:—

FOSSIL FUNGI FROM THE TERTIARY BEDS OF SILESIA. Described by Professor Göeppert, F.M.G.S.

Coniomycetes. Ecidium (Pers.) *E. subcornutum.*

Pyrenomycetes. Hysterites (Göep.) *H. serialis.* Upon leaf of *Salix varians* (Göep.) Elsewhere I find a figure of this, under a slightly different name. Here it



is:—Upon the same fossil willow-leaf two other species of epiphytical fungi were detected, *Sphærites perforans* and *S. vagans*, and a third plant grower, found upon *Carpinus ostryoides* (Göep.), from the same sandstone, has been named *Xylomites maculæformis.* Some highly interesting living fungi are figured in colours in the "Acta" of the Society of Naturalists of Bonn (vol. xxvii.), recently published. One species of Boletus in particular deserves notice, *B. rubro-poninosus*, on account of its extreme beauty; the pileus and stem being bright crimson dotted with deep red, and the tubes being deep green, with bright light green intervening flesh.

Polyporites (?). *P. Bowmanni* (Lind. and Hutt.) Coal measures of Wrexham. *Hysterites labyrinthiformis* (Unger). On leaves, miocene schists of Radobojum, Croatia. *H. opegraphoides* (Göep.)

Zylomites. Z. umbilicatus (Unger). On leaves, miocene schists, Radobojum. *Z. zamitæ* (Göep.) On fronds of Zamia at Bambergam.

Excipulites. E. Neesii (Göep.) On frond of *Hymenophyllum zobelii.* Coal-measures of Waldenberg, Silesia.

Nyctomycetes (Hart.) *N. antediluvianus* (Unger). On leaves; miocene of Gleichenberg. *N. entoxylinus* (Unger). On fossil wood, of Asseras, Egypt.

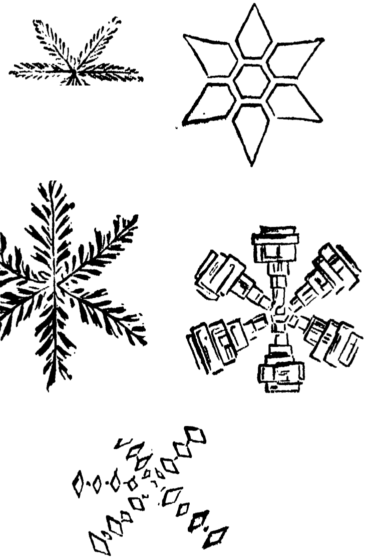
Rhizomorpha (Roth.) *R. fossilis* (Göep.) On fossil wood (Betula), upper tertiary (?), Muskau, Silesia.

There are, I believe, two or three other species of fossil epiphytical fungi described in a work on Fossil Thallogens, by M. Debey, of Aix-la-Chapelle, to which I regret I have not access. From time to time new species are brought out in the "Transactions of the Royal Academy of Vienna."

I am not aware of any fossil fungi having been yet detected in the rocks of this kingdom, with the exception of the single *Polyporites* described by Lindley and Hutton, and to which a query may be attached. The miocene leaf-beds in the Isle of Man would probably furnish some species of epiphytical genera if they were well searched. GEORGE E. ROBERTS.

Mr. Noteworthy's Corner.

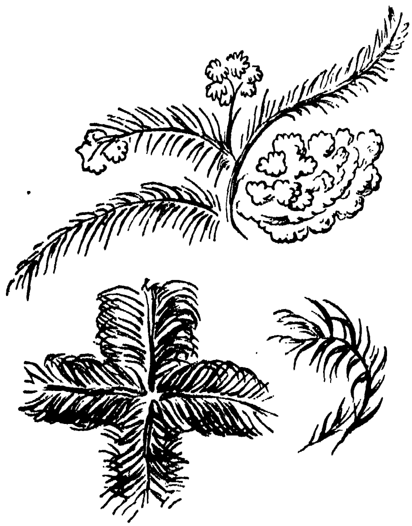
SNOW-STARS.—Either the generality of mankind have not very good eyes, or else they have no great inclination to make use of them: they say they like to see what there is to be seen; and they often go very much out of the way to gaze at what is but little worth their notice, while objects of the greatest beauty, and, as works of the great Author of beauty, most deserving of regard, are overlooked while lying immediately around them. We are not about to speak of microscopic researches. When you talk to your friends of calling in such optical help you at once alarm them. They have no microscope, and would not know how to use it properly were you to place the



Particles of Snow.

instrument before them. We are addressing non-microscopists, desiring to direct their attention to the more minute, indeed, but still easily seen parts of Nature, under the conviction that they may find the purest satisfaction, and much profitable food for thought, in a line of study which is open to all, whether poor or rich, if they have but an average share of those faculties which are usually dealt out to our race. Good part of half a century ago, Dr. E. D. Clarke, the Professor of Mineralogy at Cambridge, made a tour in Russia, and published an account of it. Among much that was new and surprising, he dwelt at special length upon the phenomenon of the wonderful star-shaped crystals of the snow in those frozen regions; and he adorned his handsome and very costly

quarto volume with plates of beautiful figures, to convince his readers that it was no fanciful resemblance to stars, such as they might see on the panes of glass in their breakfast-rooms, to which he was introducing them, but such forms as his own university might glory in, true mathematical stars, some with simple rays, like the star of heraldry, but more often divided and sub-divided—cut, as botanists would call it—like the leaf of a fern, or still more elaborately. We confess that it afforded us as much amusement as wonder when we first met with these plates, and read Dr. Clarke's description of these supposed hyperborean curiosities, familiar as they were to our observation in the streets of London. Many a time and oft had we admired them as they lay upon the sleeves of our great coat—it was long before wrappers had come into vogue—which, protecting them from the heat of the



Crystallizations of Frost on the Window.

body, gave us the opportunity of observing them, as with breath held in, we took as near a view of the incomparable little crystals as we dared, well knowing, from frequent disappointment, that the heat radiated from the face was quite enough to reduce them to water in an instant. Forty years have passed away, and Dr. Clarke's snow-stars appear to be almost as little known as ever. Professor Tyndall, speaking in his "Glaciers of the Alps" of a winter morning on the Mer de Glace, says: "At 9.30 the storm was so thick that I was unable to see the men at the stakes, which they had reached at that time, and the flakes sped wildly in their oblique course across the field of the telescope. Sometime afterwards the air became quite still, and the snow underwent a wonderful change. Frozen flowers, similar to those I had observed on Monte Rosa, fell in myriads. For a long time the flakes were wholly composed of these exquisite blossoms entangled together. On the surface of my woollen dress they were as soft as down; the snow itself on which they fell seemed covered by a layer of down, while my coat was completely spangled with six-rayed stars." "The atmosphere was also filled with these flowers. From the clouds to the earth Nature was busy marshalling her atoms, and putting to shame by the beauty of her structures the comparative barbarities of Art." And subsequently he tells us that these "wonderful figures" had been observed by Dr. Scoresby in the Polar Regions, Mr. Glaisher at Greenwich, and himself on the summit of Monte Rosa, and elsewhere. We suppose we may consider that it is his persuasion that these snow-flowers are something of rarities. He would scarcely have mentioned the names of their observers, and the places of observation, had he been aware of the undoubted fact that there is, perhaps, never a hard and snowy winter in England in which the ground, and every leaf, and every moving thing is not occasionally ornamented with "ten thousand times ten thousand, and thousands of thousands" of these most admirable gems of Nature. The description of their fall and appearance, quoted from him above, would apply to several snow-showers during the present winter, 1860-1861. But we are indebted to him for a most beautiful experiment and important discovery connected with these stars. He has made it evident that the change of water into ice goes on by means of a crystallization which takes this same stellar form. Having watched the production of artificial ice in Harrison's freezing machine, which effects the object by the help of brine cooled by means of the evaporation of ether, and having seen little six-rayed stars of ice forming and rising to the top of the water in the shallow tin vessels used in the process—which fact, he thinks, was never observed before—he placed a large lens in the sunbeams, so that the rays were brought to a focus in the inside of a cube of clear ice. Along the course of the cone of light thus projected into the transparent mass, lustrous spots became visible, as though so many minute mirrors had been suddenly placed within the ice, reflecting the light which fell upon them. Each of these brilliant spots was found to be surrounded by a liquid flower of six petals. At first these leaves had the form of the petal of a buttercup, with rounded outer edge; but as the flower advanced to its full size, this edge extended itself to a point, the whole six petals assuming the spear-shaped form, with more or less deeply cut sides; in short, the whole was an exact copy of the snow-star. The conclusion was obvious; the ice was melting into water piecemeal, each little portion being removed in the same shape in which it had been added, that, namely, of a star exactly like those of a common snow shower. Professor Tyndall had before him a structure of Nature's own moulding; and, as he was enabled to take it to pieces, he found that, as in all her other works, so here the most minute subdivisions of the material used were cut into forms of perfect beauty.

Something more about our Garden Snail.—I venture to add to Mr. Edgeworth's interesting paper a few observations of my own on the habits of the garden snail. I suspect that many of the empty shells found in the holes of walls are the shells of snails which have crawled in and could not get out again, either from the stones about these holes being displaced, or altered in position by winter frosts, or from the growth of ivy and other mural plants stopping up the fissure, and so preventing the snail's exit in spring. Such imprisoned snails I have frequently found in an old garden wall of my own, and which I could not draw out without breaking. Again, it is just possible that the snail and the shell may have increased in size since it entered the hole, and so retreat would be impossible. This I quite believe occurs frequently with young and inexperienced snails. Snails will, when very hungry, eat the oddest of food. I have known them devour the pink lining of pill-boxes, and to dine heartily upon an old copy of the *Times*. Gardeners are aware of this taste for literature, and label their flower-beds with china and wooden labels, instead of the old paper ones, which the snails soon found out and discussed. The glutinous secretion with which their bodies are coated is impervious to moisture, and cannot be dissolved in either rain or spring water. It soon dries when exposed to the air or sun, and hence we rarely see snails or slugs walking about in the sunshine, or on very windy days. I cannot altogether account for the glutinous trail snails leave behind them; that it enables them to pass over the surface of the earth with greater freedom in dry weather there can be no doubt; yet I believe it serves other purposes than this. May it not assist in guiding them to each other in the breeding season, they being hermaphrodites? Their sense of smell is wonderfully acute, though their organs of vision be too complicated for man at present thoroughly to understand. Snails have most truly a "telescopic eye," for it is worked much in the same way as we do that useful instrument. It also acts as a feeler, and possibly, like the antennæ of moths and butterflies, may be used as an organ of hearing. Our garden univalve is strictly an air-breathing animal, furnished with lungs or a pulmonary sac; so are all our numerous fresh-water snails, and though the latter pass so large a portion of their life at the bottom of lakes and ponds, yet they are frequently compelled to come to the surface to respire. It cannot have escaped the observation of many that the house of our garden snail is coated over with a fine transparent varnish, almost horny in its character. This varnishing of the shell the animal has particularly to attend to, or it would soon perish from the action of the atmosphere. The shell itself is composed of carbonate of lime, with a very small proportion of animal matter diffused through its substance. If the second winter's frost usually kills our poor snail, why, may we ask, does not the first? Frost, I feel more than assured, has nothing to do with the death of snails. Nature has been too provident of her creatures to permit this, and has so furnished our snail with an external covering, and a secretion to seal up the operculum, which will resist any amount of cold to which this animal may be subject. How do our shell-less snails survive the frosts of winter? *They must* be frozen, yet life is only suspended, perhaps mercifully, when no food can be procured.—Henry Moses, M.D., *Reading, Berks.*

The Rising and Setting of the Sun Physiologically Considered.—In observing the solar disc for the purpose of noting his spots, etc., I am accustomed to apply eye-pieces of various powers to my telescope, as occasion may require. One of these—a low power—gives a field of view about 40′ in diameter, and this takes in the whole disc of the sun, with a margin of sky all round, nearly 5′ in breadth. Now, whether I observe the sun at noon, sunrise, or sunset, the space occupied by it in the field of view is the same; so that this becomes at once a simple and convincing proof in itself, without resorting to more delicate contrivances, such as fixing cross wires within the telescope, so as to intersect the field of view, by means of which the difference in the apparent diameter of either body at apogee and perigee becomes very sensibly manifest. Strictly speaking, the apparent diameter of these bodies is greatest when on the meridian, they being then about 4000 miles nearer to us than when upon the horizon. This illusion is also very strikingly manifested as regards the relative distances of the fixed stars. Take for example Castor and Pollux. Do they not *seem* to appear at least three times as far from each other when rising as when near to our zenith? And yet theory and measurement show that they *actually* appear closest when nearest to the horizon, in obedience to the law of refraction in altitude.—A. L. S.

Habits of Vespa Vulgaris.—The Rev. C. Hope Robertson's remarks on my paper on wasps require me to vindicate the accuracy of my own observations. "Before I finish," were my words, "I may observe that my remarks have been entirely confined to the common ground wasp (*Vespa vulgaris*). My observations are merely true with regard to this one species." I thought that I had sufficiently warned my readers against confusing the habits of this wasp and those of other kinds. Mr. Robertson has seen wasps entering his hives, and so have other people, but neither he nor they seem to have determined what species of wasp. If the ground wasps killed bees it is probable that they would carry some of their bodies home; and often as I have watched the nests of the *Vespa vulgaris*, I have never seen one of them return home with a bee in his mandibles. The tree wasp, and another very common species of ground wasp, are both larger than the *Vespa vulgaris*, and are, doubtless, better able to cope with bees; besides, I have seen one of these insects carrying home a bee. A hasty observer might very easily not distinguish the difference, and hence, doubtless, arose Mr. Robertson's mistake. Entomology is a science that requires the greatest accuracy, and people should think twice before they impugn the veracity of others.—Richard L. Edgeworth, *Edgeworthstown.*

BRITISH SHELLS OF COMMON OCCURRENCE.

THE *Limacidæ*, or land-slugs, are represented conchologically by the thin crustaceous shells found on dissection within their mantles, being, as everybody familiarly knows, outwardly destitute of shell. This shield is protective of the cavity employed in respiration. Figs. 1, 2, 3, and 4 represent four of these shields, extracted from the milky, yellow, tree, and spotted slugs respectively (*Limax agrestis, L. flavus, L. arborum, L. cinereus.*

These creatures, as every lover of a garden

1. 2. 3. 4.

1. Limax agrestis (the Milky Slug), *Müller*. 2. L. flavus (the Yellow Slug), *Linnæus*. 3. L. arborum (the Tree Slug), *Chautereaux*. 4. L. cinereus (the Spotted Slug), *Müller*.

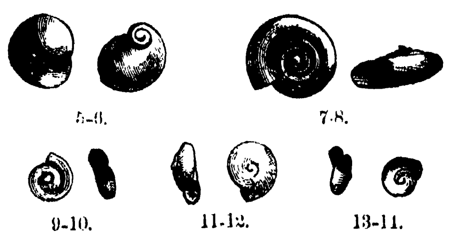
too well knows, are powerful vegetable feeders, making their appearance in damp weather in multitudes like an Egyptian plague. Their destructive voracity enables them to secrete an exuberance of white milky mucilage from their bodies, to discharge this copiously when irritated, and to mark their devouring tracks in their slime. Like linseed and other mucilaginous matter, animal and vegetable, slugs, when boiled, have been employed as a cure for consumption. When hard pressed by hunger only, will they eat dead earth-worms, and hence their blight falls chiefly on the growing plant. The observer may occasionally have felt startled to see the *Limax* suspended, by an almost invisible but very tenacious thread which it possesses the power of spinning, betwixt him and the light. This is used by the slug to drop from on high. Like the spider, it exudes this mucous thread from the secretions of its body. Encumbered with no mansion which it must carry on its back like the snail (*Helix*), the slug is yet more hardy without its shelter than the *Helix*, and remains active far into the winter, when the other lies dormant in the crevice of the wall.

The most common slug of the fields, *L. agrestis*, or milky slug, about an inch and a half long, is the most destructive of molluscous animals, devouring the roots of plants as well as their leaves. It is bisexual and very prolific, breeding several times a-year; and Chautereaux counted 380 eggs deposited by two individuals betwixt April and November, laying from thirty to seventy at a time. They rapidly increase in size, and reach maturity in three months, although they probably begin to lay eggs in about two. The *L. flavus*, or *variegatus* (for although the lower surface be yellowish-gray, the upper is thickly and irregularly-spotted blackish-brown), has a limpid slime, but secretes, when irritated, a thicker bluish-white mucus. On reaching any twig or place where there occurs a difficulty of proceeding, it allows itself to drop or be slowly lowered by its thread of adhesive mucus, which at length gives way. This is the slug which is found under damp turf and stones, beside walls and among plants. It is twice the size of the field slug, being from three to four and sometimes even five inches long. Mr. E. J. Lowe says it is best known as the cellar slug, and is in such situations gregarious. The tree slug (*L. arborum*) is grayish, with marbled side-stripes, and a dusky band along the back. It feeds upon wood and affects decaying trees, whence it uses its mucous thread to descend. The spotted gray slug (*L. cinereus*), best known as the black slug, but not to be confounded with the *Arion*, though less common than the field slug, is very abundant in damp situations, under decaying wood and fragments of stones in

gardens, hedges, etc., and in cellars and out-houses; copious rain, or even dew, enticing it from its retreat. It is the largest of the slug family, being six inches long, and will be found handsomely formed when attentively surveyed. It is circular on the back, acute and pointed at the tail; with upper tentacles of great length and short lower ones; it secretes colourless mucus. The shield is slightly stained with pink. It deposits during spring from fifty to sixty eggs, attached in heaps together, under stones and at the roots of grass and trunks of trees.

The *Helix*, or snail, has a shell spirally rolled, and although possessing no operculum, it substitutes that filmy mucous covering, by means of which it closes up its shell, and which is perforated with holes to enable it to breathe. Remaining concealed in obscurity during the day, it comes forth to feed evening and morning, or after rain, retiring from business altogether in the winter into a hole or crevice, or amongst moss, and shutting up shop till the return of solar heat. When in motion it carries its shell balanced obliquely on its back, and keeps advancing and retracting its tentacles. It is quite as destructive to vegetation as the slug.

We should have enough to do to describe



5-6. Vitrina pellucida (the Transparent Glass Bubble Shell), *Müller*. 7-8. Zonites cellarius (the Cellar Snail), *ibid.* 9-10. Z. alliarius (the Garlic Snail), *ibid.* 11-12. Z. nitidulus (the Dull Snail), *Draparnaud.* 13-14. Z. purus (the Delicate Snail), *Alder*.

all the species and varieties, for of Helices alone we may count at least forty. The *Vitrina pellucida,* or transparent glassy snail (Figs. 5 and 6), found among the putrescent leaves, moss, and decaying wood of plantations and hedge-bottoms, and also under stones, is an exceedingly thin, transparent, glossy, smooth, and fragile watery-green shell, through which the mantle of the animal within is reflected. It is elliptical in form, with three and a half depressed whorls. The shell of the *Zonites cellarius,* a cellar snail (Figs. 7 and 8), is also shining, smooth, and pellucid, and of a pale yellowish horn-colour. It is found in cellars, drains, and shady courts, in fields and woods, under stones, and amongst grass. The shell of the garlic snail (*Zonites alliarius,* Figs. 9 and 10), is nearly flat, and more convex, yellower in colour, but equally pellucid, smooth, polished, and fragile. Some of these creatures have, when alive, a strong odour of garlic, some have it on being plunged in hot water (which is the readiest way of killing them for the shell), though not when alive. Its numbers in our bag, as swept down a river, are somewhat extraordinary.

The little *Zonites nitidulus* (Figs. 11 and 12) takes from its shell the name of little shining snail. A deep umbilicus is seen in the shell. The animal is also called the "dull snail," from its leaden colour; but the shell, three-tenths of an inch in diameter, is of a yellowish horn-colour, and very like *Z. cellarius.* Another of these small shells, the delicate snail, *Z. purus* (Figs. 13 and 14), is only two lines or less in diameter; it is not very common, but, like the rest, smooth, glossy, and transparent, and may be known by its mouth, which is placed obliquely. It cannot well be confounded with *Z. radiatus,* the rayed snail shell (Figs. 15 and 16), for that, although polished, shining, and pellucid, is regularly striated or wrinkled, and is horn or amber coloured, and two lines in diameter. *Z. excavatus* (Figs. 17 and 18) is a quarter of an inch shell, of which there are multitudes in our bag, found under felled timber and

decayed wood. *Z. nitidus*, the shining snail (Figs. 19 and 20) is likewise pellucid, the colour being brownish horn, its diameter a

15-16. 17-18.

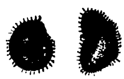
19-20. 21-22.

15-16. Z. radiatulus (the Rayed Snail), *Alder*.
17-18. Z. excavatus (the Excavated Snail), *Bean*.
19-20. Z. nitidus (the Shining Snail), *Müller*.
21-22. Z. crystallinus (the Crystalline Snail), *ibid*.

quarter of an inch. In pine-beds and damp hothouses, where it is found largely congregated, sad havoc is perpetrated by this tiny snail. The *Z. crystallinus* of Müller (Figs. 21 and 22) scarcely exceeds an eighth of an inch in diameter, and occurs amongst decayed leaves and stones.

Of the Helices proper, we figure fifteen different species; they are mostly too well known to require to be more than mentioned. Of these the largest and most familiar, *Helix aspersa*, or common snail (Fig. 23), is the

23.



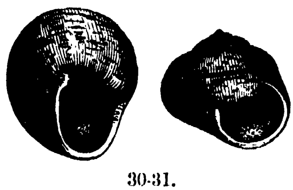
24-25.

26-27.

23. Helix aspersa (the Common Snail), *Müller*.
24-25. H. revelata (the Green Snail), *Férussac*.
26-27. H. nemoralis (the Girdled Snail), *Linnæus*.

largest and most destructive in the garden. Its usual diameter is an inch and a-half. It is olive coloured, with dark brown bands. The shell is in reality not slimy, though apparently rough on the surface. It is alleged that barrels are exported as a dainty to America, and that the London markets are largely supplied with it as a remedy for pulmonary complaints. In the United States it has been successfully acclimatized, and is now getting common. It has a penchant for nettles, wild celery, elder *Primula vulgaris*, and will climb walls, and apple and scented poplar trees, to a great height, but is capable of a long fast. Mr. Lowe mentions one that fasted 108 days in summer. The green snail (*H. revelata*, Figs. 24 and 25) is very rare and pretty. It was added by Edward Forbes in 1839; he found it near Doyle's monument in Guernsey. The yellowish-green *H. nemoralis*, or girdled snail (Figs. 26 and 27), is abundant and beautiful, and known to every one. This snail also has been introduced into North America, where it is becoming

28-29.



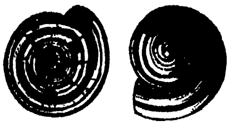
30-31.

28-29. H. hortensis (the Garden Snail), *Montagu*.
30-31. H. arbustorum (the Shrub Snail), *Linnæus*.

common. It is about seven-eighths of an inch in diameter. In about an hour after a shower, the banks they frequent become quite covered over with them, where in dry weather not one is to be found, as they retire into holes in the ground, and amongst grass, roots, and rubbish. The *H. hortensis*, garden snail (Figs. 28 and 29), is, like the preceding, very varied in its colours, though less in its size, which is three-fourths of an inch in

diameter. The shrub snail (Figs. 30 and 31), which nearly resembles this, is pretty and interesting. The zoned snail, *H. virgata*

32-33. 34-35.

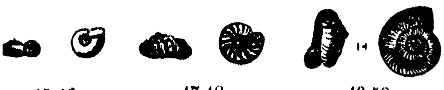


36-37. 38-39.

2-33. H. virgata (the Zoned Snail), *Da Costa*. 34-35. H. caperata (the Black-tipped Snail), *Montagu*. 36-37. H. ericetorum (the Heath Snail), *Müller*. 38-39. H. hispida (the Bristly Snail), *Linnæus*.

(Figs. 32 and 33), is more peculiar to chalk and lime districts; and the little black-tipped snail, *H. caperata* (Figs. 34 and 35), which might at first sight be mistaken for the zoned snail, is a Dorsetshire snail, added by Dr. Pulteney. Of the others which are figured, the heath snail is pale green in colour, and the bristly snail (*H. hispida*), which associates with it on the dry heath, is nearly grayish. The last shell is scattered over with bristles, but its diameter is only a quarter of an inch. The prickly snail (Fig. 42), though

40-41. 42. 43-44.



45-46. 47-48. 49-50.

40-41. H. sericea, *Draparnaud*. 42. H. aculeata (the Prickly Snail), *Müller*. 43-44. H. fulva (the Top-shaped Snail). 45-46. H. pulchella (the White Snail), *Müller*. 47-45. H. rotundata (the Radiated Snail), *ibid*. 49-50. H. pygmæa (the Pigmy Snail), *Draparnaud* (much exaggerated, see scale betwixt).

more minute, is still more remarkable from having the appearance of large prickles on its shell. Amongst these very small shells are the top-shaped and white snail, the radiated, and finally the pigmy snail, whose diameter is less than a line.

We shall still go to our bag for one more handful of miscellaneous shells, which differ much from the Helices now disposed of so far as we have got them in our budget. Our greatest regret is the absence of *H. pomatia*, the largest of the British land shells, the favourite shell food of the Romans, still eaten in many parts of modern Europe.

The *Bulimus obscurus*, dull or dusky twist shell, is considered to derive its first or generic name from a Greek term signifying insatiable hunger (βούλιμος), and its specific from the Latin, indicative of its colour (dusky or dull), for scientific jargon is generally macaronic, and by no means minds a Babel of languages. The shell is not large, being generally under half an inch in length and a couple of lines in breadth. It is unpolished in appearance; and though the animal within bears a resemblance to the Helices, or snails, the shell without tapers much more considerably, and in crawling the creature carries its shelter balanced on its back, directed a little to the right, at an angle of 50°, or drags it along the ground, and holds it when at rest at an angle of 45°. It is found in woods and under mossy trees, on walls and under stones. It crawls with speed, as if to justify the imputation of being very devouring, and of getting rapidly through its fortune. It is by no means rare in England. Macgillivray and Duncan first found it in Scotland amidst the ruins of Dunottar Castle; and it must have an affinity for old castles, as Mr. E. J. Lowe mentions as a Midland habitat Nottingham Castle yard. Three examples next turn up of the chrysalis snail shell, or pupa. Their fancied resemblance to chrysalids give the pupæ their name. They are similar in their habits to the *Bulimi*, feeding on vegetable substances; residing under mosses, herbage, or stones; inert in continued drought, and searching mostly for food at night, when

the grass is moist. Unlike the *Bulimus*, however, the *Pupa umbilicata*, for instance, is a slow mover, and carries its shell at the moderate inclination of 15°; and the shell,

51. 52. 53. 54.

51. Bulimus obscurus (the Dusky Twist Shell), *Müller*. 52. Pupa umbilicata (the Umbilicated Chrysalis Shell), *Draparnaud*. 53. Pupa pygmæa (the Pigmy Chrysalis Shell). 54. P. Substriata (the Six-toothed Chrysalis Shell), *Jeffreys*.

instead of tapering like the *Bulimus*, comes abruptly to an apex. It is very minute, usually only the ninth of an inch long and the twentieth of an inch broad. Wherever limestone or chalk abound, there it is found, whether in the cracks of old walls, amidst ivy, under stones and the bark of trees, or on the sea cliffs and valleys. If, however, the *P. umbilicata* be minute, the *P. pygmæa* is exceedingly minute, being not more than a line in length. By most authors this tiny shell, found, though not abundantly, in all parts of Great Britain and Ireland, both in wet and dry situations, but principally in dry, is classed as *Vertigo pygmæa*. The *P. substriata*, so called from its cylindrical, shining, polished little surface being streaked longitudinally, is much the same size, a line long, half a line broad, and though rare where it is found, is at the same time widely diffused from Cornwall, Devonshire, and Suffolk, to Preston, Lancaster, and Newcastle-upon-Tyne. And speaking of Newcastle-upon-Tyne, it ought to be mentioned that Mr. Joshua Alder, the great molluscous authority and *genius loci*, has pointed out a remarkable structure in the interior of the *pupa*, the use of which has not yet been ascertained. It consists of a raised thread-like laminar process, winding spirally round the columella, and similar lamina running spirally on the upper side of the volutes, with small flat transverse plaits at intervals in the interior.

The widely-spread *Balea fragilis* has been confounded with the *pupæ*, but it is far too tapering. It is a small, thin, delicate,

55. 56.

55. Balea fragilis (the Fragile Moss Shell), *Draparnaud*. 56. Clausilia nigricans (the Dark Close Shell), *various*.

shining, and rather transparent shell, of a yellowish-horn colour, and in length about the third of an inch. It is found in trunks of trees, and amidst mosses and lichens. The dark close shell, *Clausilia nigricans*, with which we have grouped it, is better known as the common *Clausilia;* but it is quite a conchologist's shell, having long escaped vulgar popularity, though very generally distributed throughout Great Britain. This exclusiveness is due to its habits and colour, which render it far from easy of detection. Its length is half an inch, breadth from a twelfth to an eighth, and it inhabits old walls. The animal, as may be inferred from the shell, is very thin and slender, so much so that in motion it is incapable of raising its shell, but drags it along in the same line as its foot and neck, although when going to repose it inclines it at an angle of 70°. It derives its generic name from a

57. 58-59.

57. Zua lubrica (the Common Varnished Shell), *Müller*. 58-59. Azeca tridens (the Glossy Trident Shell), *Pulteney*.

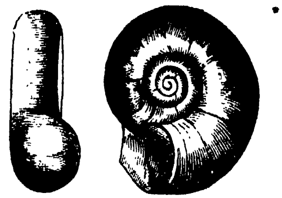
shelly bone attached to the columellar teeth, and termed the *clausium*, from closing up the aperture when the animal has retired within its habitation. The next little group,

Zua lubrica (common varnished shell) and *Azeca tridens* (glossy trident shell), are parallel in character, only the *Zua* is toothless, the *Azeca* ovate and toothed in the mouth. Both inhabit close shady wood, moss, and under stones and decayed leaves. The one is not quite, the other about, a quarter of an inch in length. The next group comprises the needle agate shell (*Achatina acicula*),

60. 61-62. 63. 64

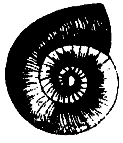
60. Achatina acicula (the Needle Agate Shell), *Müller*. 61-62. Succinea putris (the Common Amber Snail), *Linnæus*. 63. Physa fontinalis (the Stream Bubble Shell), *ibid*. 64. P. hypnorum (the Slender Bubble Shell), *ibid*.

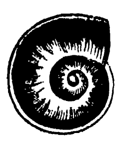
the shell of the common amber snail (*Succinea putris*), and two *Physæ* or bubble shells (*P. fontinalis* and *P. hypnorum*). The first is indeed minute, interesting, and extremely delicate, having six convolutions, though only a fifth of an inch in length; but, indeed, dead specimens found in old Saxon coffins are more frequent than living ones occurring amongst roots of grass and moss. *Succinea* is from *succinum*, amber, and *putris* means filthy; but there is nothing repulsive about the shell, which, with its variety, *S. gracilis* (slender), is found always near water, either crawling on mud or damp, or attached to succulent plants. They are never found, however, in the water. Not so *Physa fontinalis*, as its name implies, *physa* (*φυσαῶ*), inflated or blown out, and *fontinalis*, residing in springs or fountains. Yet the creature is herbivorous, feeding on the leaves, especially of *Potamogeton*, in lakes and rivers. Beneath the water it glides along with moderate, uniform motion, produced by the undulations of its foot. In the air it advances by jerks, without protruding its tentacula; and Montagu asserts that it will sometimes let itself down gradually by a thread affixed to the surface of the water, as the *Limax* drops itself from the branch of a tree. *P. hypnorum* is found in ditches and stagnant pools in many parts of Great Britain and Ireland. The mud is prolific of shells; witness the Planorbis family, of which nine species are figured below. They have been likened to



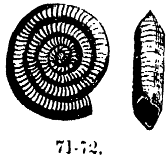
65-66.

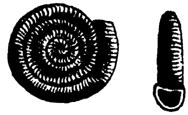
67. 68.



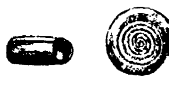


69. 70.





71-72. 73-74.

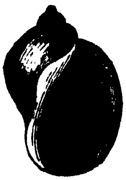


75-76. 77-78.

65-66. Planorbis corneus (the Horny Coil Shell), *Linnæus*. 67. P. albus (the White Coil Shell), *Müller*. 68. P. nautileus (the Nautilus Coil Shell), *Linnæus*. 69. P. marginatus (the Margined Coil Shell), *Draparnaud*. 70. P. carinatus (the Carinated Coil Shell), *Müller*. 71-72. P. vortex (the Whorl Coil Shell), *Linnæus*. 73-74. P. spirorbis (the Rolled Coil Shell), *Müller*. 75-76. P. contortus (the Twisted Coil Shell), *Linnæus*. 77-78. P. nitidus (the Fountain Coil Shell), *ibid*.

the fossil Ammonites, for which they might

be taken as miniature copies. The name is hence a kind of contradiction in terms, compounded of the words which signify "flat" and "ball." The largest is the *P. corneus* (Figs. 65 and 66), an inch in diameter; the others are *P. albus*, from one-fourth to one-fifth; *P. nautileus*, one-eighth to one-tenth; *P. marginatus*, five-eighths; *P. carinatus*, *P. spirorbis*, one-fourth; and *P. contortus*, one-fifth of an inch in diameter, respectively; whilst *P. vortex* is usually only from three to four lines, and *P. nitidus* two and a-half lines. These shells are found in the slow rivers, pools, and stagnant waters of England.



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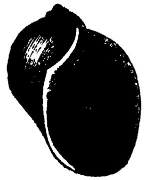


80.

81.

82.

83.

84-85.

86.

79. Limnæus auricularius (the Wide-eared Mud Shell), *Linnæus*. 80. L. pereger (the Travelled Mud Shell), *Müller*. 81. L. stagnalis (the Lake Mud Shell), *Linnæus*. 82. L. fossarius (the Ditch Mud Shell), *Turton*. 83. L. glaber (the Eight-Whorled Mud Shell), *ibid*. 84-85. L. palustris (the Marsh Mud Shell), *Linnæus*. 86. L. glutinosus (the Glutinous Mud Shell), *Müller*.

The *P. vortex* does not actually reside in the mud, but on its surface; but more especially occupies the stems and leaves of plants, both in and out of the water, retiring into recesses and cavities in the banks formed by the plants or their overlying stems or leaves. In point of fact, the mud shells, *par excellence*, are the group of *Limnæcea*, of which there are given seven examples (Figs. 79—86). The family is wide spread, the shells are fragile; and Mr. Lowe has noticed that the property of walking upside down on the ceiling, appertaining to the house-fly (*Musca domestica*), has been introduced by the Limnæus into the watery regions, "for it as easily crawls upside down on the surface of the water basking in the sun, as it moves in the ordi-

90.

87. Ancylus fluviatilis (the Common River Limpet), *Müller*. 88. A. oblongus (the Oblong Lake Limpet), *Kightfoot*. 89. Carychium minimum (the Minute Sedge Shell), *Müller*. 90. Limax brunneus (the Brown Slug), var., *Draparnaud*.

nary manner on the surface of the mud." The lake and river limpets, *Ancylus oblongus* and *A. fluviatilis* (Figs. 87 and 88) are small breathing animals; and the minute sedge shell, *Carychium minimum* (Fig. 89), though common, is almost microscopical.

The embryo naturalist, perchance, may imagine that a complete cabinet of common shells could be easily set up; but it is not every one whose enthusiasm would lead them to undergo the task. The man of science is well aware that he must trace out the wonders of the living creation in their native haunts, in order to their perfect comprehension; we are therefore glad to know that the York Natural History Society collects and sends out to subscribers the shells and fossils of different British districts and strata, at something like ten shillings a set.

WILLIAM WALLACE FYFE.

ON THE FALL OF FROGS, TOADS, AND FISHES FROM THE SKY.

MM. Duméril and Bibron, in their "Histoire des Reptiles (suites à Buffon, tome viii.)," devote several pages to what they term *Les prétendues pluies de crapauds et de grenouilles*. This very expression at once indicates their utter disbelief of the statements, or rather the accuracy of the accounts which from time to time have been laid before the public, both in the ordinary journals, and in the proceedings and transactions of scientific societies.

Incredulity may be carried too far, even in matters of science, and we ought not hastily to reject the testimony of persons who can have no motive for the practice of deception, some of them, moreover, persons of learning and science, and well capable of making accurate observations. It is not because we ourselves have never witnessed a strange and startling phenomenon, that we are to reject it as unworthy of credit; and this the writer is certain would be admitted by his lamented and highly-gifted friend now no more—we mean M. Bibron, late of the Jardin de Plantes, Paris, whose work is replete with marvellous details most interesting to the zoologist. It is true that the accounts are fairly stated, but they are sifted with that rigidity of acumen for which the French *savant* is so pre-eminently distinguished; yet, here again, so it seems to us, this rigidity may be carried too far, and we ourselves have often joked with our friend (alas! those days have passed for ever) on this very subject. It cannot be doubted but that fishes are occasionally scattered over tracts of land far from any lake, pond, or river—(but here, as may be expected, the distance varies)—and if so, as we think we can prove, why may not other tenants of lakes and morasses be acted upon by the same, or similar forces, and surprise, by their unexpected appearance, the occupants of the necessarily limited district where they fall? Why may not the frog, myriads of which inhabit the marshes and meres of temperate and southern continental Europe (we say nothing of other countries) be carried up in its tadpole, or very young state, and precipitated alive like little fishes?

But though, on certain occasions, a fall of frogs or toads in their young condition, when they congregate in multitudes together, may have taken place, we expressly guard ourselves from saying that this is always the case whenever a sudden appearance of these reptiles in vast multitudes takes place, in spots where they had not been previously noticed, or at least not in such myriads. Showers of rain call them from their lurking holes, or other obscure retreats. At the same time we would ask, "Is this the *rationale* on every occasion?" MM. Duméril and Bibron say it is.

True it is that, in our island, statements of such occurrences are to be received with caution; and, with respect to frogs and toads, we know not that we can advance anything positively demonstrative of their descent from on high. At the same time, if we turn to France, and other vast portions of the Continent, what have we in England to compare with the morasses, waste watery lands, woods, and what would be called jungles in India—to the cultivated lands, the trim hedges, the inclosed fish-pools, nay, even the *meres* and *lakes* of our island. In some parts of France, dykes, ditches, and marsh lands nightly resound with the croak of frogs (that is, in spring and early summer), one species of which is a delicacy for the table. Well, we have no such frog-nurseries in our country; we have sometimes scarcely enough of these reptiles to feed trout, pike, and sizeable perch. How then can we expect *showers of frogs?* We say, therefore, that in our highly-

cultivated (and almost frogless island) such precipitations cannot be expected.

Less frequent also are "*showers*" of fishes in our island than on the Continent; nevertheless, the instances on record are tolerably numerous, and we may easily suppose that all have not been made public.

In Hasted's "History of Kent" occurs the following narrative:—"About Easter, 1666, in the parish of Stanstead, which is a considerable distance from the sea, or any branch of it, and a place where there are no fish-ponds, and rather a scarcity of water, a pasture field was scattered over with small fish, in quantity about a bushel, supposed to have been rained down from a cloud; there having been at the time a great tempest of thunder, rain, and wind. The fish were about the size of a man's little finger. Some were like small whitings, others like sprats, and some smaller, like smelts. Several of these fish were sold publicly at Maidstone and Dartford." A writer commenting on this narrative, says—"The hypothesis that the fish had been rained down from a cloud, is one which certainly taxes the powers of belief."

In the year 1830, the following appeared in a local Scotch newspaper:—"On the 9th of March, 1830, the inhabitants of the island of Ula, in Argyleshire, after a day of very hard rain, were surprised to find numbers of small herrings strewed over the fields perfectly fresh, and some of them exhibiting signs of life." It cannot be doubted that the fish were lifted up by a strong driving wind, and carried inland to the spot on which they fell.

A writer in "Rees' Cyclopædia," says—"The raining of fishes has been a prodigy much talked of in France, where the streets of a town at some distance from Paris, after a terrible hurricane, in the night, which tore up trees and blew down houses, were found in a manner covered with fishes of various sizes." The people absurdly believed them to have been generated in the air, and to have fallen from the clouds; but it was soon found that a well-stocked fish-pond had been blown dry by the hurricane; the great fish only, too heavy to be lifted up, being left at the bottom.

The subjoined extracts from the *Times*, March 10th, 1859, will at least command attention:—

"SHOWER OF FISH IN THE VALLEY OF ABERDARE, GLAMORGANSHIRE, SOUTH WALES. *To the Editor.* Sir,—Many of your readers may perhaps like to see the facts connected with this phenomenon. They will be better understood in the words of the principal witness, as taken down by me on the spot, where it happened. The man's name is J. Lewis," etc.:—

"'On Wednesday, February 2nd, I was getting out a piece of timber for the purpose of setting it for the saw, when I was startled by something falling all over me, down my neck, on my head, and on my back. On putting my hand down my neck, I was surprised to find they were little fish. By this time I saw the whole ground covered with them. They were jumping all about; they covered the ground in a long strip of about eighty yards by twelve, as we measured afterwards. That shed (pointing to a very large workshop) was covered with them, and the spouts were quite full of them. The brim of my hat was full of them. My mates and I might have gathered bucketsful of them. We did gather a great many, about a bucketful, and threw them into the rain-pool, where some of them now are. There were two showers with an interval of about ten minutes, and each shower lasted about two minutes or thereabouts. The time was eleven A.M., the morning up-train to Aberdare was just passing then. It was not blowing very hard, but was very wet; the wind was rather stiff (as to-day), and from the south-west. The fish came down in a body with the rain, as it were.'

"Such is the evidence I have taken for the purpose of being laid before Professor Owen, to whom I shall send eighteen or twenty of the little fish. Three of them are large and very stout, measuring about four inches in length, the rest are small. There were some (but since dead) fully five inches long. They are very lively.

"JOHN GRIFFITH,
"Vicar of Aberdare and Rural Dean.
'Vicarage, Aberdare, March 8th, 1859."

What the species of fish were we have not learned, bnt probably stickleback, minnows, and young fry.

In the *Critic*, for March 5th, 1859, is a notice of the foregoing occurrence, taken from the *Monmouthshire Merlin*.

In India, falls of fishes appear to be far more frequent than in Europe, and we continually receive notices of them.

"I was," says a gentleman, "as incredulous as my neighbours, until I once found a small fish, which had apparently been alive when it fell in the brass funnel of my pluviometer, which stood on an insulated stone pillar, raised five feet above the ground, in my garden."

In September, 1839, writes another gentleman,* "In a spot about twenty miles south of Calcutta, at two in the morning of the 20th instant, we had a very smart shower of rain, and with it descended a quantity of *live fish*, about three inches in length, and all of one kind only. They fell in a straight line from my house to the tank, which is about forty or fifty yards distant. Those which fell on the hard ground were, of course, killed from the fall; but those which fell where there was grass sustained no injury, and I picked up a large quantity of them *alive* and *kicking*, and let them go into my tank. The most strange thing in connection with this event was, that the fish did not fall *helter-skelter*, here and there, but in a straight line, not more than a cubit in breadth."

A lady, residing at Moradabad, in a letter to a friend in England, gives an account of a number of fish which had fallen in a shower at that place. Of these many were springing about on the grass in front of the house. This account, accompanied by a drawing of one of the fish, taken from the life at the moment, was read before the Linnæan Society. The fish was identified as a small species of *cyprinus*, two and a quarter inches long, green above, silvery white below, with broad lateral bright red lines. It may be said that there is something indefinite in these and other instances which we *could bring forward in abundance*, and that the observers were not scientific. But this objection (quite valueless) will not apply to Sir James Emerson Tennant, whose History of Ceylon is now before us. He assures us that the descent from above of small fishes is not so uncommon (in Ceylon and India) as might be supposed, and such a fish-shower he himself witnessed. "I was driving," he writes, "in the Cinnamon Gardens, at Fort Colombo, and saw a violent, but partial shower of rain descend at no great distance before me. On coming to the spot, I found a multitude of small silvery fish, from one and a-half to two inches in length, leaping on the *gravel* of the highroad—a number of which I collected and brought away in my palankin. The spot was about half a mile from the sea, and entirely unconnected with any watercourse or pool."

It is, as he observes, by the action of tornadoes and violent storms, that these fishes (usually small fry), are whirled up, and in a short time allowed to fall. This observation equally applies to young frogs and toads, the fall of which is altogether denied by MM. Deméril and Bibron.

Sir J. E. Tennant adduces, on undeniable authority, numerous instances of the fall of

* See "Journal of Asiatic Society, Bengal," vol. vi. p. 465. Paper by Mr. J. Prinsep, Secretary to the Society

fish, accompanied by heavy showers of rain. "Mr. Whiting, who was many years resident at Trincomalie, states to me that he had often been told by the natives, on that side of the island, that it sometimes rained fishes, and on one occasion, he adds, 'I was taken by them in 1849 to a field near the village of Karran-cotta-tivo, near Batticaloa, which was dry when I passed over it in the morning, but had been covered in two hours, by sudden rain, to the depth of three inches, and in which there was then a quantity of small fish. The water had no connection with any stream or pond whatsoever.'"

Dr. Buist, of Bombay (we follow, though not verbally, Sir J. E. Tennant), collected a number of instances relative to the fall of small fish from the clouds, brought down by heavy rains or tornadoes. (See *Bombay Times*, 1856.)

Dr. Buist, after enumerating cases in which fish were said to have been thrown out from volcanoes in South America, and also precipitated from the clouds in various parts of the world, adduces the following instances of similar occurrences in India: "In 1824 fishes fell at Meerut on the men of Her Majesty's 14th regiment, then out at drill and were caught in numbers. In July, 1826, live fish were seen at Moradabad during a storm. To this we have already alluded. On the 19th of February, 1830, at noon, a heavy fall of fish occurred at the Nokulhatty factory in the Dacca Zillah. Depositions on the subject were obtained from different parties. The fish were all dead; most of them of large size (contrary to the rule); some were fresh, others were rotten and mutilated. They were seen at first in the sky like a flock of birds descending rapidly to the earth. There was a drizzling rain, but no storm."

On the 16th and 17th of May, 1833, a fall of fish occurred in the Zillah of Futtehpoor, about three miles north of the Jumna, after a violent storm of wind and rain. The fish were from one and a-half to three pounds in weight (another exception to the rule), and of the same species as those found in the tanks of the neighbourhood. They were all dead and dry.

A fall of fish occurred at Allahabad during a storm in 1835. They were of the *chowla* species, and were found dead and dry after the storm had passed over the district.

It must be evident that large and heavy fish, falling on the subsidence of a tornado, would, as a consequence of their own weight, be mutilated and killed on coming to the ground; while little, light fishes, especially if falling on grass, would survive the trifling shock, leap about as roach, dace, or perch do, when thrown out of a boat on to the grassy bank of the river. For example, in addition to others already cited:—On the 20th of September, 1839, after a smart shower of rain, a quantity of live fish, about three inches in length, all of the same kind, fell at the Sunderbunds, about twenty miles south of Calcutta. On this occasion it was remarked that the fish (as in some other instances noticed) did not fall here and there irregularly over the ground, but in a continuous straight line, not more than a *span in breadth.*

We would here, by way of parenthesis, observe that the vast multitudes of fish with which the low grounds round Bombay are covered about a week or ten days after the monsoon, appear to be derived by flooding from the adjacent pools or rivulets, and, as Sir J. E. Tennant observes, not from the sky. We would suggest that they may have issued from buried and torpid spawn, or, as is perhaps more probable, have emerged from their tombs in the indurated mud which covered them.

This æstivation (analogous to hybernation in colder regions) of fishes, crocodiles, and reptiles in general, and even insects, throughout India, certain portions of Africa, and meridional America, is of ordinary occurrence during the burning dry season. It affords a subject full of interest. We have other re-

cords of falls of fishes at Kattaywar on the 25th of July, 1850; at Poonah, on the 3rd of July, 1852; and we might extend the list even to the fatigue of the reader.

Let us now turn, not to *dogs and cats*, which are sometimes said to be rained down from the sky; but to young frogs and toads, the descent of which, during a raging thunder-storm, is far more likely than that of the afore-named respectable mammalians.

We shall adduce the testimony of witnesses worthy of credit; and although we fully admit that after a severe drought multitudes of such reptiles are very suddenly, nay, almost instantaneously, called forth from their concealed lurking places, viz., holes and cracks in the ground (as noticed in the case of lizards by Virgil), or deep chinks and fissures on the bark of old forest trees, still we would contend that other causes *do sometimes* operate in producing the sudden appearance of numbers of such creatures confined within a limited spot of ground.

We will adduce the testimony of M. Peltier, as given October 20, 1834, to the meeting of the Academy of Sciences, Paris. This scientific gentleman relates a fact which he himself witnessed in his younger, but not less observant days, in nearly the following words:—There was a storm which, advancing, spread itself over the little town of Ham, in the department of the Somme, where he then dwelt. He was observing its menacing progress, when, all of a sudden, the rain fell in torrents. He then saw the market-place, or "place de la ville," covered with little toads. Astonished at what he saw, he stretched forth his hand, and received on it the shock of a number of these creatures. The courtyard of the house was filled in the same manner as the "place." He saw them fall on a roof of slates, and thence rebound upon the pavement. The whole multitude took to the streamlets, and were so carried away from the town. Within the course of half an hour the place was cleared of them, with the exception of some laggards, which appeared to have been grievously injured or bruised by their fall. M. Peltier then adds, "Whatever may be the difficulty in accounting for the transportation of these reptiles, I by no means the more hesitate to affirm the fact, which has left profound traces on my memory by the astonishment it caused me."

The celebrated M. Arago (a venerated name) followed up this communication by the remark that M. Peltier was too well known by his scientific labours to lead to a suspicion that he had lightly observed the circumstances of the phenomenon of which he had thus made a detailed report. At the same meeting (*séance*), M. Duméril himself read a letter relative to the subject from a lady, who did not wish her name to be given, but whose father has left a reputation dear to science, of which he was an enlightened and illustrious patron. This lady's communication is as follows:—"In September, 1804, I was out with my husbsnd, following field sports in the park of the Château d'Oignois, near Senlis, where we dwelt. It was about noon when the thunder growled vehemently, and, all of a sudden, the daylight was obscured by an enormous black cloud. We instantly took the road to the château, from which we were then at some rather considerable distance. A clap of thunder of extraordinary force broke the cloud, which poured upon us a torrent of toads (*un torrent des crapauds*), mingled with a little rain. This rain seemed to me to last for a pretty considerable time; and, indeed, on further reflection subsequently, I am very nearly certain that it continued at least a quarter of an hour."

We have here two strong witnesses, whose testimony is not to be thrown aside with a sneer, or passed over with a shrug of the shoulders. Both these writers were of some little worth; the former a man of high scientific note, the latter a lady of rank and cultivated intellect.

Some other notices of the fall of *toads*, if

toads they were, meet us; but they are either too vague to be depended upon, or almost repetitions of the previous narrations; we may therefore pass them by. We will now select one from many examples of the fall of *frogs*, seeing the reptiles above instanced are expressly stated to have been *toads*.

M. Duparcque writes thus to the *Académie des Sciences*:—"It was on a Sunday in August, 1804, after many weeks of drought and heat, after a suffocating morning, that a violent storm burst forth, about three after mid-day, over the village of Fremard, four leagues from Amiens. I was at the time in the company of the curate of the parish, and in crossing the small close which separates the church from the parsonage, we were inundated; but what surprised me was to receive on my person and dress numbers of little *frogs*. 'It rains toads,' said the venerable curé, who remarked my astonishment; 'but it is not the first time I have seen this.' A great number of these little animals were leaping on the ground. On arriving at the parsonage-house, we found the floor of one of the apartments completely covered with water, the window on the side against which the storm was driving, having been left open. The ground of the close was paved with bricks closely wedged together, so that these animals could not have emerged from under the ground. The window sill was elevated about two and a-half feet above the ground, so that they could not have gained entrance from without by leaping; and, again, the apartment was separated from the entrance-hall or passage by a very large dining-room, having its two windows open, but in such a direction that the rain could not drive in through them; consequently neither water nor frogs were to be seen there: I say *frogs*, for from the green colour of the back, the whiteness of the under surface, and the length of the hind legs, it was easy to recognize them." M. Duparcque expressed an opinion that the little frogs in question were swept up by a whirlwind with probably a portion of the water of some morass, and M. Arago remarked that water can be conveyed by the wind, without losing its liquid or ordinary state, to great distances. He had, in fact, been informed by Mr. Dalton (the great English chemist and philosopher) that he had collected positive sea-water, in a pluviometer, seven leagues from the coast, which water had been carried inland by the wind.

Other instances are on record, attested by M. Zichel (1808); Colonel Mannier (Oct. 13, 1834), etc. etc.

"Naturalists," says M. Duméril, "know that this sudden apparition of little frogs on the surface of the earth, and in places where they did not appear to have previously existed, has in all times awakened the attention and curiosity of people who supposed these animals to have fallen from the sky. In fact, we find traces of this belief in Aristotle, in some passages of Athenæus, and in Ælian; turning to the moderns, in Gesner, in many volumes the ephemerides of the curious things of nature (*Ephemerides des curieux de la Nature*), in the works of Ray, and in those of Rédi." M. Duméril passed over in review the acrimonious discussions of scientific men: Cardan was sharply attacked by Scaliger for his faith in the cloud-born and spontaneous generation of these reptiles. Pison thought that the young creatures did not fall fully formed from the sky, but that they were engendered by the fecundating agency of the rain on the clods of rich earth ("*les mottes de terre grasse*"). Lentilius averred, that from all that was said he saw only a *chimerical*, and not a spontaneous generation. Rédi asserted that these little reptiles were all along concealed in chinks of the earth, under stones and clods, where the eye could not perceive them, by reason of their immobility, and often of their dull colour.

In the present day, this opinion of Rédi has been usually adopted, and, as a general rule, we accept it. But then come in the

fishes, and the testimony of intelligent persons who positively affirm that they were witnesses of their descent.

M. Duméril urges the time of the year in which these phenomena occur, viz., the time in which the tadpoles have just undergone their last stage of transformation, and having changed gills for lungs, cast off the swimming tail and acquired legs, and scatter themselves far and wide over the open country, wandering to a great distance from their native waters. While thus wandering in vast hordes, heat and drought supervene; they at once seek out fissures, holes, and the like, in which they ensconce themselves, closely squatted and concealed, till the welcome rains call them forth from their retreats. Their case is analogous to that of the troops of fishes which in India and Ceylon wander overland, and bury themselves in the mud till revived by the heavy showers of the monsoon.

That M. Duméril has made out a good case, we fully admit; but until a decided negative can be given to the asserted fa[ll of] fishes, it does not appear to us to be [?] "proven" that similar falls of young [am]phibia, congregated in shoals over the m[ud]-water of lagoons, shallow meres, and exten[]sive morasses, such as we see on the adjacen[t] Continent* (where sudden whirlwinds, *tour[]billons*, and terrible deluges of rain are fre[]quent), may not occur, at least from time [to] time, to the surprise of the educated, as we[ll] as of the ignorant. If not, wherein lies the value of *bonâ fide* testimony, the witnesses being unprejudiced and straightforward, in contradiction to theory, and to learned opinions, as to what, after all is a matter, not of opinion, but fact?

W. C. L. Martin.

* M. Duméril states that he has seen this sudden apparition of frogs after a warm shower, *unaccompanied by any storm*, once in Picardy, and a second time near Marbella in Spain. In the latter instance, the swarm consisted of tree-frogs (*Hyla*).

WAYSIDE WEEDS AND THEIR TEACHINGS.

HANDFUL THE LAST.

"Then think I of deep shadows on the grass,—
Of meadows where in the sun the cattle graze,
Where as the breezes pass,
The gleaming rushes lean a thousand ways."

Russell Lowell.

Just let us remind our readers that we are among the straight-veined monocotyledons or one-seed lobed plants, and that this second great division of the vegetable kingdom is itself divided into two sections, the petaloid and the glumaceous plants, or those in which the floral envelopes are more or less corolla or flower-like, and those which have only chaffy scales to inclose and protect their essential organs of reproduction—the stamens and pistils.

With respect to the petaloids, we need scarcely say that the beautiful blossoms we reviewed in Handful VI. all belong to the section, but there are a good many other genera also claiming to be admitted within the petaloid boundary, which are by no means so flower-like. Indeed some of them, because they cannot show a proper flower, seem as if they would not show any, and have nearly naked blossoms. Nevertheless, we shall find some of the less conspicuous of

the petaloids sufficiently interesting. The ıceous or scale-flowered division of h plants is composed of two tribes only, sedges or *Cyperaceæ*, and the grasses or :*mineæ*. The former are comparatively important; of the importance, or rather necessity of the latter, to man and animals, ıs scarcely requisite to speak. We fear the umaceous section of Flora's family is often :ked by the novitiate botanist; partly, at ıt, from an exaggerated idea of the difficulties which attend its study, and partly from the comparatively unattractive exterior of its members. Let us assure our readers that the difficulties are not so great, and that the interest well repays the trouble of surmounting them, such as they may be. But to these we shall return. Space compels us to bid you gather in one "handful" certain examples of the petaloids left unnoticed in our last paper, and with them the glumaceous plants too, and we shall find you plenty of both falling within the category of "Wayside Weeds," and none more so than, as the child's hymn speaks—

> "The rushes by the water
> We gather every day."

What plant so familiar as that with which we began our first experiments in textile manufacture—who does not remember it?—copying the nurse-maid or elder sister as she wove rush caps, baskets, and all the varieties of rush handicraft. Every one knows rushes, so get a few; but, remember, in blossom, that is, with the loose bunch of flowers protruding from the side of the straight round stem. There are many different species of the rush proper, but we fear to confuse by trying to distinguish between them, so simply gather the rush in flower. The wood-rush, especially the field species, is a Wayside Weed too, but it is a chance whether its reddish brown heads of blossoms, and bright yellow stamens, which show abundantly in spring, have attracted the attention of learners; nevertheless, look out for the plant, or for the greater hairy wood-rush (Fig. 102), which grows in

FIG. 102.—Plant of Hairy Wood-rush.

woods. These wood-rushes, with their flat hairy leaves, are very different from the common rush, as you may see. If you are in a moor country you should put beside them the bog-asphodel, really a pretty flower, which from its abundance may well be called a weed. It, too, belongs to the rush tribe. The water plantain you must often have seen, its broad, long-stalked leaves, and dif-

fuse panicles of small pale rose-coloured blossoms, standing up from some pool in summer, or from ditches by the side of railway embankments, which are favourite sites for it. It, too, is a wayside petaloid, and so likewise, in some places, is the arrow-head with its beautifully shaped leaves. Then into the same section come crowding a large following of pondweeds; you know these plants with dark olive green leaves, floating on most pond surfaces, from which the little flower spikes shoot up in early summer; and, lastly, there is the duckweed of our stagnant waters, which all summer long covers and protects them with its brilliant green fronds, till the ice covering surprises and supersedes it. If we have not already filled your hands too full, make way for a few glumaceæ. If you can recognize a sedge or two, get them, and any grass, from oats to meadow grass, which you can find in blossom, will do well to illustrate what we wish to say. You look distrustfully at your handful, the members of it seem so different from the plants you have been all along examining. Let us see? Do not forget the trine members of the straight-veined division, and go back to your rushes. Take a wood-rush blossom (Fig. 103), and examine it through your lens. A three-stigma capped style in the centre is surrounded by six stamens, and these again by six segments of perianth or floral envelope, which are, as you will see, not petals exactly, but approaching thereto. The blossom of the rush proper you will find is not very different, but in some examples the stamens number three only.

FIG. 103.—Blossom of Wood-rush, showing perianth in six divisions, and style with three stigmas.

The bog-asphodel, a first cousin of these rushes and wood-rushes, which has come out in bright yellow, and which holds itself half a foot high, or a little more, on the wet moorland on which it grows, has very much the same characters as its relatives; moreover, the capsules or seed-vessels of all are either quite three-celled, or imperfectly so, and three-valved; thus you see the ternate divisions of the monocotyledons kept up.

A rush, and a flowering one, but not a true rush either, we omitted to bid you gather, but it is common enough at times to make it at least a pondside weed. The handsome umbels of the tall "flowering rush" would indeed set off your handful, and well illustrate, in all its characters, our present divisions. Knowing these characters, it is sufficient to bid you compare the water plantain and the arrow-head—if you have got them—with the same standard. There is one plant, the arum or wake-robin (Fig. 104), common enough in England, and commonly known, which belongs to this our petaloid section. We have already quoted it in Handful VI. for its singular and conspicuous bract or spathe, but it is so very diverse in appearance and structure from the usual types of the section, we have forborne to add it to your collection, fearing confusion. Remember, however, at some future day that the wake-robin is a petaloid monocotyledon; but all ternate division of organs is lost, the stamens and pistils (Fig. 104) are indefinite in number, the perianth is wanting,

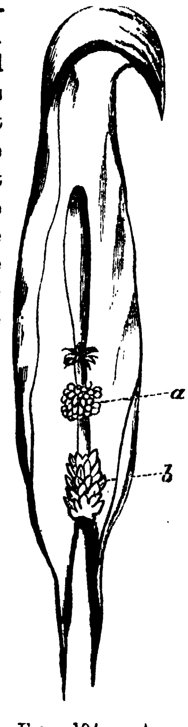


FIG. 104. — Arum Spathe, including essential organs of plant reproduction;—*a*, stamens; *b*, pistils.

and its place is supplied by the interesting bract or spathe.

Quite as abnormal in its way, from our type, is this funny little duckweed which puzzles you altogether; you see a little leaf or a series of little leaflets—fronds they are often called—all conjoined, with a little water-root depending from each, but where the flower is, or even should be, is past your comprehension. The fact is, this little duckweed, so called because it affords frequent food to water-fowl, chooses rather to increase by means of little buds which take the place of the stamens and pistils, and so each little leaf throws out other little leaves on each side, but does not throw them off, for they remain attached to their parent, and these again, when they are old enough, send out their own little leaflets, and so on they go covering the surface of the pool from the fierce heat of summer, giving shelter and house-room to myriads of watery little beings, and offering at the same time a wonderful example of a most attached family. Nevertheless, examine closely, and in some of the little fronds, or frondose leaves, you may find the two little stamens, and the wee little seed-vessel which is all this duckweed, or, as the botanist calls it, Lemna, has to offer. Do not confuse yourself by trying to connect this curious and beautiful little plant with the other petaloids generally, but look at it simply as one of our wayside weeds, well deserving in itself your attention. Moreover, do not omit to examine the delicate sheaths which tip the root fibre of each little leaflet.

Passing on to the glumaceous or second section of the British monocotyledons, we find it divided between the cyperaceous or sedge tribes, and the gramineæ or grasses. As regards the former, we much fear that few of our uninstructed readers will recognize them as wayside weeds, common as they are. The cotton grass, it is true, attracts attention when its many heads of white, cottony, almost silky, fibre whiten the moorland in summer, but then all the flowering characters are gone. The bull-rushes or club-rushes may be known to some, but the sedge proper, or *Carex* family, is the most numerous in the division, numbering almost seventy British species. We must rest content with one illustration (Fig. 105), which may lead you to recognize the first sedge you meet with by land or water. The barren spike (Fig. 105, *a*) consists of stamens only, with a single scale (Fig. 105, *c*) at their base. These wither up after flowering. The fertile spikes (Fig. 105, *b*) consist of pistils only, each likewise supported by its scale (Fig. 105, *d*), which finally protects the fruit (Fig. 105, *e*). The stems are of well-marked triangular form (Fig. 105, *f*). With some little resemblance to the grasses, the sedges are yet very different, as the descriptions prove, and more diverse still in their useful import. Comparatively, the sedge has rarely any economical value; the grass tribes, directly or indirectly, are the staple of man's material life.

FIG. 105.—Carex stricta, or Tufted Bog-sedge: *a*, barren spike; *b b*, fertile spikes; *c*, *d*, scales of perianth; *e*, fruit, or seed; *f*, section of stem.

Important, however, as the second or gramineous division of the British *Glumaceæ* may be, we must dismiss it with but short notice. It would be quite useless to attempt to discriminate for a beginner the differences between the tribes or genera of grasses; it must suffice to point out the parts of the grass blossom, or the peculiarities of the grass plant, and leave those who wish to confirm

them for themselves. Take any grass you chance to meet with, but a large species, with, what you probably call, the seeds large too will be best. Observe, first, the narrow straight-veined leaves, and next, the cylindrical hollow stem with joints and knots at intervals, the leaves sheathing the stem. The seeds or blossoms are disposed in spikes as in the case of wheat or barley, which, perhaps, it is unnecessary to say are real, true grasses, or more loosely in panicles as in oats. Now take one of these grass blossoms (Fig. 106),

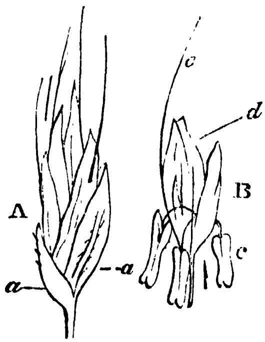


FIG. 106.—A, Spikelet of Brome Grass; *a a*, glumes or involucre, inclosing grass florets. B, Single Floret of Brome Grass; *d*, glumellæ, or perianth; *e*, stamens; *c*, awn.

and if the plant really be in blossom, you will observe hanging out the loosely-attached stamens—"versatile" is the proper botanical term—three in every distinct species of British grass, but one, the sweet-scented meadow grass, which has only two stamens; you will, probably, also observe the little feathery stigmas protruding beside them. The scales or paleæ, or valves, for they have all these names, which include the stamens and styles, are, as you will observe, generally in pairs (Figs. 107 and 108); a number of pairs making up a little spikelet (Fig. 108). From the extremities of the scales, generally the outer one, but often from their back arise long, thread-like projections, which have the name of awns. Barley, rye, and the beautiful feather-grass afford us some of the best examples of the awn in full development. Of course these awns give valuable characters in distinguishing the various species of grass from each other; but if you will examine the diverse scales which compose the spikelet, or locusta, as it is called, you will find they have many distinctive marks besides: some are more or less covered with hairs; some have many or few veins or nerves; and whilst some are pointed at the apex, others are blunted, and others "bifid," or forked.

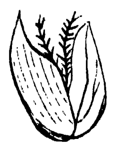


FIG. 107.—Floret of Melis Grass, showing feathering stigmas.

We have yet, however, to speak to you of the structure of this flower spikelet as a whole. The outer and lower pair of scales or glumes (Figs. 106 and 108) were at one

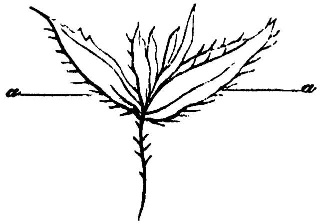


FIG. 108.—Spikelet or Locusta of Meadow Soft Grass; *a a*, glumes or involucre, inclosing florets.

time regarded as equivalent to a calyx, but as in many grasses they inclose a considerable number of florets, they are now more properly regarded as bracts, constituting an involucre, such as we remember in our old friends the composites, consequently the pairs of scales inclosed by the glumes, instead of being equivalent to a corolla, must be looked on as the perianth of the blossom. These inclosed scales are often called *paleæ*. The grass stem gets the distinctive name of *culm*.

SPENCER THOMSON, M.D.

VITAL DYNAMICS.

AMONG the discoveries which from time to time reward the patience and perseverance of the experimenter in physics, there are some which stand alone and almost unrelated, others which open up a wide and unexplored territory, or are rich with relations to facts already known. Discoveries of this latter sort are few and far between, but when they do occur they mark a new epoch in the history of science. Her pioneers, cutting their slow path through opposing difficulties, suddenly find a road, broad and solid as a Roman way, stretching on before them, and the mist and darkness rising from around voyagers who have not seen sun or stars for many days, new land is disclosed and a silver sea. Perhaps we could not find an illustration more to the point than that which is furnished by the nineteenth century, in the discovery of the true nature and relations of heat.* We may even make a more general statement, for heat is only one of a class of phenomena over their ignorance of which former physicists drew the decent veil of a high-sounding name, and ascribed them to the "Imponderable Substances." Of these the chief were caloric, light, and electricity. Instead of being forms, we now regard them as rather states or properties of matter; or to make a yet higher generalization, as so many forms of force, each interchangeable with the other, and that in certain definite proportions. It is this interchangeability, this equivalence, as forms of force, of certain quantities of heat, light, electricity, and chemical affinity, which is peculiarly the discovery of this century.

* In a previous paper, "The Labour of the Sunbeams," we merely touched upon principles which we intend to expand in the present. Between the two, the reader will have a complete view of one of the grandest and most perfect systems of relations in natural science.

It is a law of Nature that force can neither be created by us nor destroyed; we can only make it assume different forms, so that there is no such thing as using a force in the sense of annihilating it. We use it by making it pass from one state into another; from the state of chemical affinity, for example, to the state of heat, of light, of electricity, or of work done, or of any combination of the four. It may be asked, where has that proportion of the chemical force gone which results in work done? Here, in order to answer the question intelligibly, we must study that form of force called heat, and its relations to work done, which form the principles of thermo-dynamics,* and lie at the foundation of the whole science of energetics.

The history of the discovery of these relations is long and interesting, but our sketch must be brief. In the years 1842 and 1843, it was observed, almost simultaneously, in Germany, in England, and in Denmark, that the temperature of water might be raised by stirring, or otherwise subjecting it to friction; and that there seemed to be some definite proportion between the force expended in stirring and the heat produced. There has been some dispute as to awarding the honour of this observation; but while there seems to be no doubt that each observer acted independently, there is still less that our countryman, Joule of Manchester, has, by his elaborate experimental determination of the actual gain in heat for the actual expenditure in force, made the discovery his own. These experiments extended over a term of several years before they led to a certain result, for it must not be supposed that to raise the temperature of water,

* The evolution of chemical force is studied in three branches—thermo, electro, and vital dynamics.

or any other fluid, by simple friction to an appreciable degree is an easy process. It is beside our present purpose to describe Joule's mechanical arrangements, or the varied results which he at first obtained, owing to the rudeness of these arrangements. Whatever the method, and whether the fluid was water, oil, mercury, or air, the general conclusions were the same. An amount of mechanical energy, whether of the muscles of the experimenter or of weights running down, was expended, and the sole effect produced was the evolution of heat in the fluid. Was there any definite relation between this heat and the work expended? Joule proved that there was, that every unit of heat represented a fixed number of units of work. The British unit of heat, or thermal unit, is "the quantity of heat which will raise, by an interval of one degree of Fahrenheit's scale, the temperature of one pound of distilled water, at or near its temperature of greatest density."* The simplest form under which we can contemplate work is as weight raised to a certain height. When we speak of work, therefore, we mean the space traversed into the resistance overcome, the height into the weight. In Britain, space being measured by feet and resistance by pounds, the British unit of work is called a *foot-pound* *i.e.*, the work done in lifting a weight of one pound to a height of one foot. In other countries the units are adapted to the national modes of measurement. Expressed in this phraseology, Joule found that in all cases a British thermal unit is equal to 772 foot-pounds of work; or, in plain terms, if you agitate a pound of water till you raise its temperature one degree Fahrenheit, you have expended as much energy as if you were to lift a weight of 772 pounds to a height of one foot; or, what is the same thing, carry a pound up a hill 772 feet high. To undo such work, or reconvert it into heat, the pound of matter must be let fall from this height. It would then generate heat by friction of the air, but chiefly by the energy of its inpingement on the ground, just enough to raise a pound of water one degree Fahrenheit in temperature.

It is evident that this law cannot be limited to heat produced under any particular circumstances; but that wherever we find heat, and however it is produced, whether by friction of solids or fluids, or by chemical action, its mechanical equivalent is the same. The generalization does not terminate here. In 1834, Faraday demonstrated the "identity of the chemical and electric forces." In 1840, Joule announced the law of the development of heat in a voltaic battery. It is proportional to the electro-motive force, or the intensity of the current; and, further, that the heat caused by the combustion of any body is proportional to the intensity of its affinity for oxygen. Here we have an evident relation between the heat and the electro-motive force; and the mechanical value of heat being known, the actual mechanical value of chemical affinity and of electricity might be calculated. When, therefore, Joule demonstrated that if we set a battery to do work by turning an electro-magnetic engine, that proportion of chemical force which does not evolve as heat, passes into the form of the force or work of the engine, nothing more was wanting to prove that not only heat and work done, but all the various forms of energy are convertible in equivalent proportions. The practical conclusion of the whole matter is this. Once determine how many thermal units will be developed in any chemical combination, and you have a constant quantity. No matter where that combination may take place, in the voltaic battery, in the furnace of a steam-engine, or in our own tissues, we can determine the greatest amount of work which it can possibly perform, and the mechanical value of every form of force which it can assume. Such constant

* "The Steam-engine and Other Prime-movers," Prof. W. J. M. Rankine, p. 244.

quantities have been determined by Mr. Joule, and Professor William Thomson, of Glasgow, and in the hands of the latter especially, we may say that a new phase has been given to modern physics—definiteness for uncertainty; numerical measurement for vague guess-work. If it is a pound of zinc to be consumed in a battery, no matter whether it be allowed to heat the fluid and the wires, to turn an electro-magnetic engine and propel the Russian professor's* shallop on the Neva, or to flash along the telegraph wires, and make the needles vibrate with intelligence; we know exactly the mechanical value of all the work that pound of zinc can do. Is it a pound of coal to be burned? You may make it propel the locomotive, set the busy wheels of the factory in action, turn the rollers of the steam printing-press, perform any of a thousand-and-one offices through the agency of steam, or distil from it the gas which illuminates our homes and our streets; still, not a fraction more than the predetermined work or force can be tortured out of this pound of coal. Is it, again, a pound of beef to be conveyed into the stomach, or a pound of corn for provender to the horse? We can tell exactly how much pith there is in the beef and corn, and not a foot-pound more of work could either man or horse extract from them. Nor is there a fraction of the original mechanical value of the zinc, the coal, or the food lost. On the one side we have the store of energy in the chemical affinity of this zinc, and coal, and food. If, on the other, with the actual work done, we were to collect and sum up all the heat developed in the fluids of the battery, and the bearings of the magnetic engine, all the heat lost from the boiler, in the condenser, and elsewhere in the steam-engine; all the heat produced at the piston, and the various bearings in the machinery, the electricity developed, and the loss of heat by evaporation, and otherwise, in the horse and man; and, in each case, the mechanical value of the unconsumed zinc, and coal, and food, we should find the equation perfect.

* Professor Jacobi, who published in 1835 an account of experiments on electro-magnetic engines.

After this rather lengthy introduction, we may, in terms which without it must have been unintelligible, define vital dynamics as *the application of the principles of the dynamical theory of heat to organisms endowed with life, whether animal or vegetable.* Animals are regarded as machines, or media for the economic development of the energy of their food; plants as store-houses of that energy. The natural tendency of the mind is to view living creatures as original centres of force, matter being permeated by a peculiar independent source of power, called *life;* but, as we said in our previous article, "Life is rather a dispenser than a producer of force." In the mechanical contrivances of man, we have no great difficulty in demonstrating the source of power; but life is so subtle and delicate in its outgoings as to baffle our finest methods of analysis. Let us see how far we can carry this analysis. Animals form one of three media enumerated by Joule, by which chemical force may be evolved; the other two being the electro-magnetic engine, and the various kinds of thermal engines. It would thus appear that in inorganic machines chemical force is the sole source of their power, and to produce this power it becomes either electrical force or heat. Do organic machines derive all their power from food? and if so, are we to add a third medium, or does the potential energy* of our food develop itself as in either of the two classes of dead machines?

* It is of primary importance that the reader should understand this and a cognate term. *Potential energy* is a power of and tendency towards change, which, when satisfied, will produce an equivalent in *actual energy.* Thus the potential energy of the food is its chemical affinity, or tendency towards oxygen, and power of combining with it which, when satisfied, develops actual energy of electricity, animal heat, and motion of external bodies.

We need hardly at this day discuss the question whether animals derive all their power from food. There is an evident ratio between food and power; we hope to show that they do not develop more power than their food would afford, and on general demonstrated physical laws we know that they cannot destroy force, and are led to expect that they do not create it. There is, therefore, the greatest probability, verging upon certainty, that animals are, as Joule assumes, merely media for the evolutions of chemical force. How is it done? Have animals a distinct, peculiar method of developing chemical affinity as muscular force? The question is one of extreme difficulty, but our present knowledge distinctly points to a negative answer. If there be such a force as a *muscular* or *vital* force, distinguished from the other forms of force already enumerated, it owes its separate existence to its incomprehensibility. It is a mere name, and ought not to allay scientific inquiry, or lead us to believe that we understand the dynamics of life. It would be quite impossible to discuss, within reasonable limits, the question, under which of the known and acknowledged forms of chemical force is the energy of our food evolved? The processes of oxidation in the animal body and in the voltaic battery are strikingly alike; electricity is somehow connected with every muscular act as experiment has amply proven; there are animals having the power of discharging electricity from their bodies at will; the only excitant which will cause contraction by *direct application* to muscular tissue is electricity; in short, there are many facts in favour of the supposition that muscular force is really electrical force. The difficulty lies in deciding whether electricity is a mere concomitant or a preceding form of the force developed in muscular contraction.

While passing through this region of doubt and conjecture, the reader must not think that the safety of vital dynamics as a theory is in any way involved in these doubts and conjectures. This depends on the truth of the following proposition, that the chemical forces of the food are sufficient to account for all the forms of energy developed in and by the animal, whether of heat, of electricity, or of work; or that in any given time the mechanical value of the animal heat, of the electricity, and the actual work done, equals the mechanical value of the food consumed. It will appear evident from this statement how indispensable a sufficient theory of animal heat is to the attainment of any accuracy in tracing the development of the energy of the food. Before the time of Lavoisier, it would not have been possible to make any of the necessary calculations. The data were wanting; nor were they furnished until long after Lavoisier's famous researches, for he, and all subsequent experimenters to the time of MM. Fabre and Silbermann, under-estimated the heat of combination of carbon and hydrogen with oxygen. The latest and most thorough proof of the chemical origin of animal heat is that of Gavarret in his valuable little book, "On the Heat Developed in Living Creatures." In a chapter entitled a "Comparison of the causes of cooling and of the sources of heat" in animals, he tabulates the results of the most correct determination of the carbon and hydrogen consumed; calculates the amount of heat due to this chemical action; and shows that, after the cooling processes of evaporation, radiation, and conduction are all supplied, a very large surplus is left. One feels at once impelled to the conclusion that this surplus represents work done. In a horse there is a surplus per hour of 678 calories, or French thermal units. This is equal to rather more than 2,000,000 foot-pounds; and Watt's estimate of horse-power per hour being 1,980,000 foot-pounds, it follows that the horse actually can develop in mechanical effect nearly the whole of this surplus. Similar calculations with reference to man give a similar result. The great dif-

ficulty in making all such estimates arises from those variable circumstances which are peculiar to vital machinery. The activity of the respiratory and nutritive functions, and therefore the amount of animal heat, is proportional to the work done. Changes in external temperature affect the heat within. Lavoisier found that in man exercise almost triples the amount of oxygen consumed. Prout says that slight exertion raises the proportion of carbonic acid in expired air between three and four per cent.; while in the horse Lassaigne found it considerably more than doubled by a quarter of an hour's exercise. Becquerel has proved that during contraction the temperature of a muscle always rises, sometimes as much as 1° Cent. These are difficulties with which we have not to contend in organic machines. They arise from the elastic, adaptive nature of vitality, and prevent us from attaining to any degree of nicety in our calculations. It is probably owing to this that these calculations have not been made with a view to assign the value of each form of energy developed from the food, and so to exhibit an equation, but to discover the economy of chemical force when evolved by living creatures, as compared with its economy in dead machines. By *economy* is meant that proportion of chemical force which is made to do useful mechanical work in the service of man. The highest limit of this economy in dead machines has been determined, so that a comparison shows which is the most efficient way to employ chemical affinity, whether in the galvanic battery, the furnace, or the stomach. The problem then is—*Given the work done, and the food consumed, to find the thermal equivalent or possible work of the chemical forces of this food, and therefore the proportion economized.*

The first, and, so far as we know, the only published attempt to solve the problem, as regards a vital organism, was made by Messrs. Scoresby and Joule in 1846. An account of their experiment is given in a joint paper (published in the "Philosophical Magazine" for that year) "On the Power of Electro-magnetism, Steam, and *Horses*." According to Watt, the value of a horse-power per day is twenty-four million foot-pounds. To sustain a horse in working condition, twelve pounds hay and twelve pounds corn per day are necessary food. Therefore, said these gentlemen, the combustion of one grain of this mixture enables him to raise one hundred and forty-three pounds to the height of one foot. It was found by experiment, that when burned, one grain raised the temperature of a pound of water ·682°, an amount of heat equivalent to 527 foot-pounds. The horse, therefore, converts into useful mechanical effect ·27, or somewhat more than a fourth of the entire potential energy of its food. The remaining three-fourths is partly expended as animal heat, partly undeveloped in the excretions, which represent the cinders of a furnace. From the absence of any definite standard estimate of man-power, calculations as to its economy vary somewhat in their results; still, from this very want, a necessity for drawing data from actual cases of work has been imposed, so that we have more faith in the truth of these results than in those concerning the horse. Prof. Thomson seems first to have attempted a rough estimate. "Probably," says he,* "as much as one-sixth of the whole work of the chemical forces arising from the oxidation of his food during the twenty-four hours, may be directed to raising his own weight by a man walking up hill for eight hours daily; and, perhaps, even as much as one-fourth of the work of the chemical forces may be directed to the overcoming of external resistances, by a man exerting himself for six hours daily in such operations as pumping." Lavoisier † made

* "Philosophical Magazine," vol. iv. p. 286.

† Mem. de l'Acad. des Sciences, 1787, p. 575.

a number of very interesting experiments on his colleague, Seguin, as to the consumption of oxygen by man in various circumstances: fasting and at rest in various temperatures; fasting and performing external work; digesting and at rest; digesting and performing work. By applying to these data our principles, it is found that in working while fasting, ·148 of the chemical action is economized, while if food had been recently taken the proportion fell to ·109. The decrease is owing to the activity of the respiratory processes during the first stages of digestion. The most recent calculations are those of Helmholtz, in his admirable lecture "On the Conservation of Force," delivered recently before the Royal Institution. He proceeds on the data of Dulong, Despretz, and Dr. E. Smith, and reckons that in working a treadmill or climbing a hill, "the fifth part of the equivalent of the work which is produced by the chemical process, is really gained as mechanical work."

Scarcely any attempt has been made to call order out of the chaos of facts, physiological and mechanical, which have been established regarding muscular motion and work, and of which the above is only a small sample. The following theory has, at least, the merit of being intelligible; though it would require many more experiments to establish it thoroughly. Vital chemical processes are divisible into *general* and *special*. General chemical action is independent of the will, it is everywhere diffused, and advances, rising and falling with the mere physical relations of the body. It expends its energy chiefly in the production of animal heat, but partly also in maintaining the muscular current of electricity. Special chemical action is distinguished from general —(1), by being voluntary, or the result of special nervous influences; (2), by being local, confined to the muscles in action; (3), by expending a large proportion of its energy in mechanical effect. In the heart and other involuntary muscles, this expenditure is probably caused by local irritation and reflex action; in voluntary muscles by the will: the special chemical action is superadded to the general; part of the tissue combines with oxygen, and the potential energy of their affinity is developed chiefly as work done, and that most probably through the medium of electricity. These recall to mind that law of the muscular current that it suffers a sudden and great diminution at the moment when contraction begins. It has been observed, also, and amply proved both in living and dead muscle, that this diminution "is not permanent even when the contraction seems to be so, as in the state of tetanus; but it is composed of a rapid succession of simple and sudden variations in intensity."* Let us derive an illustration from the electro-magnetic engine. Suppose we send the current which is to turn it through a galvanometer. If we observe its indicated strength before we allow it to turn the engine, and then suddenly permit the engine to move, what do we remark? That the indicated current instantaneously diminishes. Part of it has been transformed into work done in the engine. So, when the muscles contract, the muscular current at once diminishes. Part of it has been transformed into work done by the limb in which the contraction occurs. But this diminution is not constant; it shows minute variations. What does physiology tell us of the state of a muscle while in action? "The sustained active contraction of a muscle," says Bowman, "is an act compounded of an infinite number of *partial and momentary* contractions, incessantly changing their place, and engaging new portions in succession." We have, therefore, in the muscular current, not only the general indication of a state of contraction, but a

* For the best *resumé* of the facts of electro-physiology, see "De la Rive, Treatise on Electricity," vol. iii. chap. i., from which we quote.

rise and fall corresponding to the alternately relaxed and tense state of the ultimate fibres. The more we think on these facts and the analogy of the electro-magnetic engine, the more we feel convinced that here, in our own bodies, there is a transformation of electricity into muscular energy or work done. If not, where does the electricity go?

If this theory of special and general chemical action be true, it ought to be found on experiment that in any case, if we ascertain the amount of oxygen consumed during rest, and subtract it from the amount consumed during the performance of a known work so as to get the increase, and if we estimate the mechanical value of this increase, it should be equal to the work. This has actually been done. Matteucci observed that the fresh muscles of frogs *always* absorbed oxygen, and gave off carbonic acid. This was the general chemical action, diminished greatly in vigour, owing to absence of vitality. He observed, besides, that during contraction this "muscular respiration," as he calls it, was more than trebled. This was the special chemical action; the mechanical value of which in ten gastrocnemian muscles of the frog, he calculated to be ·657 foot-pounds, while the effective work was ·577, or only ·08 of a foot-pound less. The difference is fully accounted for by a slight rise in temperature, which accompanied contraction, and which is, of course, always greater in living tissue. This constant seeming loss in every vital chemical action of a portion run to heat is not, as in a mere steam-engine, really loss. The maintenance of the temperature is essentially connected with vitality; and therefore with the work an animal is capable of performing. Even in a dead muscle Matteucci found that a certain amount of heat was requisite to contraction. It lost that power entirely, after being surrounded for a little with ice, and regained it only when dipped in water at 60° or 70°.

As economic* producers of mechanical effect from chemical forces, animals are placed in the present stage of investigation just beneath the electro-magnetic engine, and greatly above both the best steam-engine yet made, and the best which can be made. The electro-magnetic engine has been made by Joule to develop in work done as much as one-half the force at its disposal; while the horse develops somewhat more than a fourth, man probably a fifth, and the best Cornish engines a tenth. Man is, therefore, mechanically inferior to the horse. In a commercial aspect the order is exactly reversed, from the difference in expense of keep between an engine—steam or magnetic—a horse and a man. Since the "almighty dollar" is in the end the sovereign power, we use coals instead of zinc, and are whirled along the railway, not by electricity, but by steam.

There is yet another aspect under which we may view the dynamics of vitality in man—in their relation to the manifestation of intellect or spirit. Man then at once resumes his true place—"In action, how like an angel! in apprehension, how like a God! the beauty of the world! the paragon of animals!" The expenditure of a portion of these chemical forces is one of the conditions of the existence and healthy action of the soul within us. We have seen that the heat of our frames cannot be regarded as waste, as it unquestionably is in the steam-engine. It is a condition of animal life. But the intimacy between the healthy performance of the functions of animal and of spiritual life has been acknowledged at least as far back as the saying of the Latin poet, *mens sana in corpore sano.* Further, it is an open question how far the exercise of intellect is accompanied by chemical change. There is a definite relation between mind and organism, between development of brain and range of faculty. We know that healthy action within that range is dependent on the due nourishment and inte-

* See former paragraph for definition of *economic*.

grity of structure of the brain, and may, therefore be sure that the brain, in the process of thinking, etc., does undergo molecular destruction of tissue. Structural disease ensues if the balance between waste and repair is not maintained, or if the organ is overworked, and the mind is either crippled or destroyed, so far as manifestation goes. "Fresh fields" open up before us as these thoughts pass through our mind; but it would hardly be consistent with the nature of this journal to enter them. We halt upon the borders of that everlasting mystery of mind and matter. One remark only we make, and that regards Carpenter's theory of "Mind and Force."* If the reader has apprehended the principles we have been discussing, he will see that it is inadmissible. It is advanced as a compromise between materialist and spiritualist, but is itself most material of all. Were it true, the mystery would be none the less. Mystery is inherent in the idea of mind and of matter, and, until the ideas are changed, the mystery must remain. All that our investigations permit us to say is, in the most general terms, that the chemical forces of the human body are expended partly as the condition of animal and spiritual life, partly as useful work done through the medium and at the will of the life so maintained. The mechanical economics of animals generally, but especially of man, are, therefore, not only the most perfect, but, we may say, absolutely perfect. JAMES B. RUSSELL.

Royal Infirmary, Glasgow.

* "Principles of Human Physiology," 5th edit., p. 552.

SMEE'S GALVANIC BATTERY.

BESIDES the batteries described in the article at page 20 of the present volume, there is yet another which, though composed of materials not quite so easily accessible to the country resident, is nevertheless so simple in its construction, so effective in use, and so readily prepared for service, that a popular and minute account of it can hardly fail to prove acceptable. This battery is the invention of Mr. Smee, and has always borne his name. It may consist of a single cell, or of a series of cells, each of which is a repetition of the first. Hence it will be necessary to describe one cell only, connection between the cells of a series being always made by connecting the positive plate of one with the negative plate of the next.

The non-oxidizable plate of this battery is made of silver foil. In its simple state, however, this metal would be by no means effective, as it becomes covered with minute bubbles of hydrogen gas immediately the connection is made between it and the zinc element, by which its power is very seriously impaired. This inconvenience is completely obviated by depositing upon the entire surface of the silver a layer of platinum, by means of the electrotype process. The deposit of platinum thus formed, although to the naked eye apparently smooth, consists of minute spiculæ, from the points of which the hydrogen is thrown off as fast as it is generated by the zinc plate. The platinized silver thus preserves its efficiency for a great length of time.

It would hardly be worth the experimenter's while to prepare this plate for himself. It may be ordered by the square inch, and being very thin and light, may be sent to any part of the kingdom by post at the cost of a penny.

The oxidizable plate, as in the batteries before described, consists of zinc, but not in its simple form. Experience has shown that

commercial zinc, being impure, is largely consumed without contributing in any way to the force of the electric current; while, if the zinc be absolutely pure, the whole quantity consumed contributes to the force of the current. It is not, however, necessary to obtain pure zinc in order to attain the same end, for experience again has shown that if ordinary zinc be amalgamated, that is, alloyed superficially with quicksilver, its electro-chemical actions are as effective as those of pure zinc.

The casting of zinc plates, and their subsequent amalgamation, are amusing experiments; and as the intelligent manipulator may prefer making them for himself, we will describe a way of doing it at small cost.

Two pieces of chalk or soft-stone (Fig. 1)

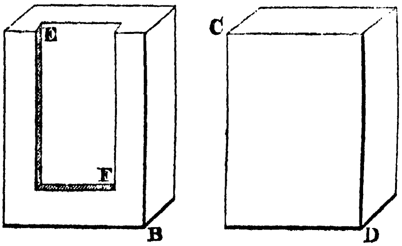


FIG. 1.

are squared up; and one surface of each, A B and C D, are rubbed together till they become smooth and flat. In the surface of one, a broad even depression, E F, is worked out, about one-eighth of an inch deep, and with a breadth and length corresponding to the size of the plate required. The surface of this depression, too, must be made as smooth and even as possible. When a plate is to be cast, the face C D is laid upon the face A B, and the blocks are bound tightly with a piece of cord. Crude zinc is then melted in an iron ladle, and poured into the orifice at E. When cold, it must be removed with care, so as not to injure the mould.

To amalgamate the zinc, immerse each plate for a few minutes in dilute sulphuric acid—say one acid to five water—and as soon as the plate is clean and bright, rub over both surfaces with mercury by means of cotton wool; the mercury will immediately combine with the zinc, and yield a lustrous superficial amalgam, in virtue of which the plate will last much longer, and at the same time be vastly more effective.

Supposing our plates prepared, we have now to consider how to put them together, and form a battery. Fig. 2 gives a dissected

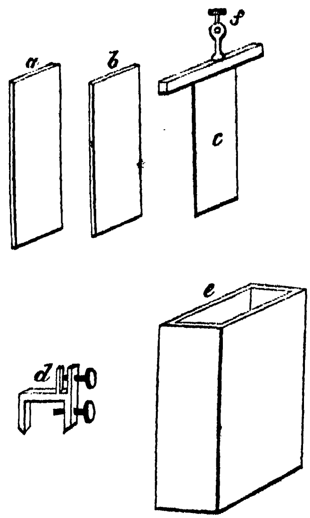


FIG. 2.

view of all the pieces required: *a* and *b* are the two amalgamated zinc plates; *c* is the platinized silver plate fixed into a piece of wood, and brought into metallic communication with the binding screw *f*; *d* is a clamp and screw for binding the plates together, and making a connection between the zinc and platinum elements; *e* is an earthenware jar in which to place the elements when the battery is to be put to work; and for this an ordinary round jar may be substituted, if one of the other kind is not at hand. To put the apparatus together, the plates *a* and *b* are

applied to *c*, and fixed to it by means of the

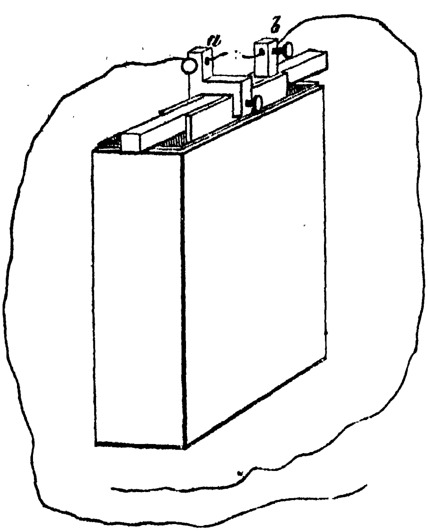


Fig. 3.

clamp *d*. Some care will be necessary here in order to secure a perfect metallic connection between the two zinc plates, while these are as completely disconnected from the platinum plate and the binding screw *b*, Fig. 3.

The plates are now put into the jar, and made to rest on it by means of the piece of wood between the plates, as shown at Fig. 3. By connecting the binding screws *a* and *b* through the wires, and charging the battery with dilute sulphuric acid (one acid and six water), a current of great vigour and constancy is set up, and may be conducted to any piece of apparatus as desired, just as in the batteries before described.

It is one of the advantages connected with the use of this battery, that it does not when in action give off noxious or offensive fumes, and consequently is not injurious to the furniture or apparatus of the apartment in which it is employed.

RICHARD BITHELL.

LIST OF PLANETS.

(Continued from page 7 of Vol. I.)

Sign.	Names of the Planets.	Date of Discovery.	Discoverer.	Place of Discovery.	Number each Observer has discovered.
57	Mnemosyne	1859, September 22	Luther	Bilk	8
58	Concordia	1860, March 24	Luther	Bilk	9
59	Elpis	1860, September 12	Chacornac	Paris	6
60	Danaë	1860, September 9	Goldschmidt	Paris	12
61	Echo	1860, September 14	Ferguson	Washington	3
62	Erato	1860, September 14	Forster and Lesser	Berlin	1
63	Ausonia	1861, February 10	Gasperis	Naples	8
64	Angelina	1861, March 2	Tempel	Marseilles	1
65	Maximiliana	1861, March 9	Tempel	Marseilles	2
66	Maia	1861, April 10	Tuttle	Cambridge, U.S.	1
67	Asia	1861, April 17	Pogson	Madras	4
68	Leto	1861, April 29	Luther	Bilk	10
69	Hesperia	1861, April 29	Schiaparelli	Milan	1
70	Panopea	1861, May 5	Goldschmidt	Paris	13
71	Niobe	1861, August 13	Luther	Bilk	11

Nine planets were discovered in 1857 and in 1861, eight in 1852, six in 1854, five in 1856, 1858, and 1860, four in 1855, three in 1847 and in 1850, two in 1851, and one in 1801, 1802 1804, 1807, 1848, 1849, and 1859. Goldschmidt has discovered thirteen, Luther eleven, Hind ten, Gasperis eight, Chacornac six, Pogson four, Ferguson 3, Olbers, Hencke,

and Tempel two, and Piazzi, Harding, Graham, Marth, Laurent, Searle, Schubert, Forster and Lesser, Tuttle, and Schiaparelli one each. There is a striking difference in the number discovered each month: two were discovered in December and June, three in January, February, and July, four in August and November, six in October, seven in May, nine in March, thirteen in April, and fifteen in September; so that on an average of twenty years we may be tolerably certain of the discovery of a planet in September; whilst it is ten to one against a discovery in June or December.

E. J. LOWE.

METEOROLOGY OF JANUARY.

FROM OBSERVATIONS AT HIGHFIELD HOUSE OBSERVATORY.

Year.	Mean elastic force of vapour, or the pressure due to the water contained in the air.	Mean pressure of dry air, or the pressure due to the gases of the air.	Mean weight of vapour in a cubic foot of air.	Mean degree of humidity 100 = complete saturation.	Mean quantity of water in a vertical column of the atmosphere.	Weight of a cubic foot of air.
	Of an inch.	Inches.	Grs.		Inches.	Grs.
1848	0·200	29·658	2·4	0·91	2·8	557
1849	0·234	29·418	2·7	0·96	3·2	547
1850	0·186	29·665	2·2	0·90	2·6	558
1851	0·239	29·334	2·8	0·88	3·3	543
1852	0·223	29·320	2·6	0·87	3·0	545
1853	0·238	29·303	2·7	0·88	3·3	544
1854	0·209	29·366	2·5	0·88	2·9	548
1855	0·185	29·822	2·4	0·89	2·6	557
1856	0·200	29·241	2·4	0·89	2·8	548
1857	0·186	29·408	2·1	0·88	2·6	553
1858	0·189	29·919	2·2	0·84	2·6	561
1859	0·209	29·742	2·4	0·85	2·9	550
1860	0·193	29·242	2·2	0·86	2·7	549
1861	0·180	29·799	2·1	0·91	2·5	563
Mean	0·205	29·517	2·4	0·89	2·8	552

The mean elastic force of vapour, *i. e.*, the pressure of the barometer due to the water contained in the air, is for January of the past fourteen years 0·205 of an inch; ranging between 0·180 of an inch in 1861, to 0·239 of an inch in 1851—a difference of 0·059 of an inch.

The mean pressure of dry air, or the pressure due to the gases of the atmosphere at the height of 174 feet above the mean sea-level, for January of the past fourteen years, is 29·517 inches; ranging between 29·241 inches in 1856, and 29·919 inches in 1858—a difference of 0·678 of an inch, or nearly seven-tenths of an inch.

The mean weight of vapour in a cubic foot of air for January, during the past fourteen years, is 2·4 grains, ranging between 2·1 grains in 1857 and 1861, and 2·8 grains in 1851—a difference of 0·7 of a grain.

The mean degree of humidity (complete saturation being represented by 1·00) for January, during the past fourteen years, is 0·89; ranging between 0·84 in 1858, and 0·96 in 1849—a difference of 0·07.

The whole amount of water in a vertical column of the atmosphere for January during the past fourteen years is 2·8 inches; ranging between 2·5 inches in 1861, and 3·3 inches in 1851 and 1853—a difference of 0·8 of an inch.

The mean weight of a cubic foot of air for January, during the past fourteen years, is 552 grains; ranging between 543 grains in 1851, and 563 grains in 1861—a difference of 20 grains.

E. J. LOWE.

ASTRONOMICAL OBSERVATIONS FOR JANUARY, 1862.

THE Sun is in the constellation of Capricornus until the 20th, and then in that of Aquarius, and is nearest to the earth on the 1st. He rises in London on the 1st at 8h. 8m., on the 6th at 8h. 7m., on the 12th at 8h. 4m., on the 20th at 7h. 57m., and on the 31st at 7h. 43m.; setting in London on the 1st at 3h. 59m., on the 10th at 4h. 11m., on the 20th at 4h. 26m., and on the 31st at 4h. 45m.

Day breaks in London on the 2nd at 6h. 3m., and on the 23rd at 5h. 53m.

Twilight ends in London on the 3rd at 6h. 7m., and on the 24th at 6h. 33m.

Length of day in London on the 1st, 7h. 51m., on the 15th, 8h. 16m., and on the 31st, 9h. 2m.

The Sun is on the meridian in London on the 1st at 12h. 3m. 52s. p.m.; on the 11th at 12h. 8m. 15s.; on the 21st at 12h. 11m. 37s., and on the 31st at 12h. 13m. 45s.

The equation of time is on the 1st, 3m. 52s.; on the 11th, 8m. 15s.; on the 21st, 11m. 37s.; and on the 31st, 13m. 45s. subtractive.

Full Moon on the 16th at 1h. 55m. a.m.

New Moon on the 30th at 2h. 50m. a.m.

She is furthest removed from the Earth on the 10th, and approaches nearest on the 26th.

Occultation of Stars by the Moon.—On the 4th, κ Aquarii (5th magnitude star) disappears at 6h. 40m. p.m., and reappears at 7h. 41m. p.m.; on the 10th, ζ Arietis ($4\frac{1}{2}$ magnitude star) disappears at 3h. 27m. p.m., and reappears at 4h. 18m. p.m.; on the 13th, No. 1 Geminorum (5th magnitude star) disappears at 10h. 34m. p.m., and reappears at 11h. 1m. p.m.

The planet Mercury is in the constellation of Sagittarius at the commencement of the month; and in that of Capricornus at its close, when he is favourably situated for observation. Rising on the 1st at

7h. 53m. a.m., and on the 31st at 8h. 21m.; setting on the 1st at 3h. 21m. p.m., and on the 31st at 5h. 57m. p.m. His diameter on the 1st is $4\frac{1}{2}''$, and on the 25th, 5".

Venus is in Aquarius throughout the month. She is very favourably situated for observation, and attains her greatest brilliancy on the 21st. Her diameter is on the 1st, 30", and on the 25th, $42\frac{1}{2}''$. She rises on the 1st at 10h. 17m. a.m., on the 16th at 9h. 28m. a.m., and on the 31st at 8h. 19m. a.m.; setting on the 1st at 8h. 18m. p.m., on the 16th at 8h. 24m. p.m., and on the 31st at 8h. 9m. p.m.

Mars is in the constellation of Libra at the commencement of the month, and in Ophiuchus at the close. He is unfavourably situated for observation. His diameter being at present only $4\frac{1}{2}''$, whilst in September it will be $21\frac{1}{2}''$. He rises on the 1st at 4h. 32m. a.m., and on the 31st at 4h. 24m. a.m.; setting on the 1st at 1h. 17m. p.m., and on the 31st at 12h. 20m. p.m. From the 8th to the 10th he is quite close to the star, ω Scorpii, and on the night of the 15th, very near to ω Ophiuchi.

Jupiter remains in Virgo during the month. On the 30th, at 4h. 13m. p.m. he is in conjunction with β Virginis, the distance being only $7\frac{1}{2}'$. His diameter is $36\frac{1}{2}''$ on the 1st, and 39" on the 5th. He rises on the 1st at 10h. 53m. p.m., on the 16th at 9h. 51m., and on the 31st at 8h. 49m. p.m.; setting on the 1st at 11h. 29m. a.m., on the 16th at 10h. 26m., and on the 31st at 9h. 26m. a.m.

Saturn is also in the constellation Virgo throughout the month. He is very conspicuous, and favourably situated for observation. His ring is invisible to us until the 1st of February. He rises on the 1st at 10h. 23m. p.m., on the 16th at 9h. 25m., and on the 31st at 8h. 23m. p.m.; setting on the 1st at 11h. 25m. a.m., on the 16th at 10h. 27m. a.m., and on the 31st at 9h. 30m.

Uranus is in Taurus throughout the month; rising on the 1st at 1h. 54m. p.m., and on the 31st at 11h. 53m. a.m.; setting on the 1st at 6h. 14m. a.m., and on the 31st at 4h. 13m. a.m.

Eclipses of Jupiter's Satellites.—On the 2nd, at 2h. 50m. a.m., 2nd moon disappears. On the 4th, at 6h. 16m. a.m., 1st moon disappears. On the 6th, at 12h. 44m. a.m., 1st moon disappears. On the 7th, at 11h. 55m. p.m., 4th moon reappears. On the 9th, at 5h. 25m. a.m., 2nd moon disappears. On the 13th, at 2h 38m. a.m., 1st moon disappears. On the 14th, at 2h. 6m a.m., 3rd moon reappears. On the 20th, at 4h. 31m. a.m., 1st moon disappears. On the 21st, at 2h. 50m. a.m., 3rd moon disappears. On the 21st, at 6h. 4m. a.m., 3rd moon reappears. On the 21st, at 10h. 59m. p.m., 1st moon disappears. On the 26th, at 11h. 53m. p.m., 2nd moon disappears. On the 27th, at 6h. 24m. a.m., 1st moon disappears. On the 28th, at 6h. 48m. a.m., 3rd moon disappears. On the 29th, at 12h. 52m. a.m., 1st moon disappears.

Magnetic Declination in London (or variation of the compass), 21° 2' W.; inclination (or dip of the needle), 68° 18' N.; total force, 10° 30'; variation of the compass at Dover about 20° 22'; at Yarmouth about 20° 22'; at Hull about 21° 22'; at Southampton about 21° 22'; at Newcastle about 22° 17'; at Liverpool about 22° 32'; at Edinburgh about 23° 7'; at Glasgow about 23° 27'; at Dublin about 23° 27'.

Stars on the Meridian.—On the 1st, Venus souths at 3h. 14m. 36s. p.m. On the 1st, Jupiter souths at 5h. 9m. 30s. a.m. On the 1st, Mars souths at 8h. 5m. 0s. a.m. On the 1st, Saturn souths at 4h. 54m. 6s. a.m. On the 1st, Mercury souths at 11h. 36m. 30s. a.m. On the 1st, Uranus souths at 10h. 2m. 24s. p.m. On the 1st, α Orionis souths at 11h. 2m. 25s. p.m. On the 1st, Sirius souths at 11h. 53m. 38s. p.m. On the 2nd, Aldebaran souths at 9h. 39m. 0s. p.m. On the 4th, α Persii souths at 8h. 7m. 47s. p.m. On the 7th, Rigel souths at 9h. 59m. 8s. p.m. On the 10th, Capella souths at 9h. 45m. 57s. p.m. On the 15th, γ Piscium souths at 5h. 54m. 35s. p.m. On the 17th, δ Orionis souths at 9h. 36m. 49s. p.m. On the 21st, α Orionis souths at 9h. 43m. 46s. p.m. On the 21st, Sirius souths at 10h. 35m. 0s. p.m. On the 27th, Castor souths at 10h. 58m. 9s. p.m. On the 29th, Pollux souths at 11h. 1m. 12s. p.m. On the 31st, Venus souths at 2h. 15m. 18s. p.m. On the 31st, Jupiter souths at 3h. 10m. 30s. a.m. On the 31st, Mars souths at 8h. 22m. 0s. a.m. On the 31st, Saturn souths at 2h. 53m. 36s. a.m. On the 31st, Mercury souths at 1h. 8m. 36s. p.m. On the 31st, Uranus souths at 8h. 1m. 0s. p.m. On the 31st, Orionis souths at 9h. 4m. 27s. p.m. On the 31st, Sirius souths at 9h. 55m. 41s. p.m.

E. J. Lowe.

Mr. Noteworthy's Corner.

Floral Designs for the Colour Top.—As an artist I have been much pleased with the "Kaleidoscopic Colour Top," and herewith submit an improvement of my own for the benefit of those who may

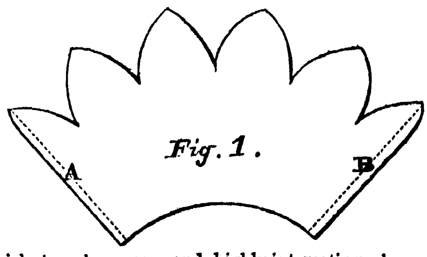


Fig. 1.

wish to enjoy a new and highly interesting phase of its capability of increasing amusement and promoting further study. A piece of moderately thin post paper coloured black (with Indian ink) on both sides should be cut out like the subjoined pattern, and the sides marked A and B fastened together with gum-arabic, thus forming something like the petals of a flower, as in Fig. 2. This, with its smaller end placed towards the three-coloured disc (the spindle being within it) will, on spinning the top, exhibit not

only the red and blue, but the purple, orange, yellow,

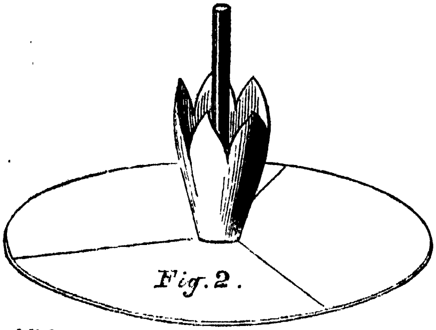
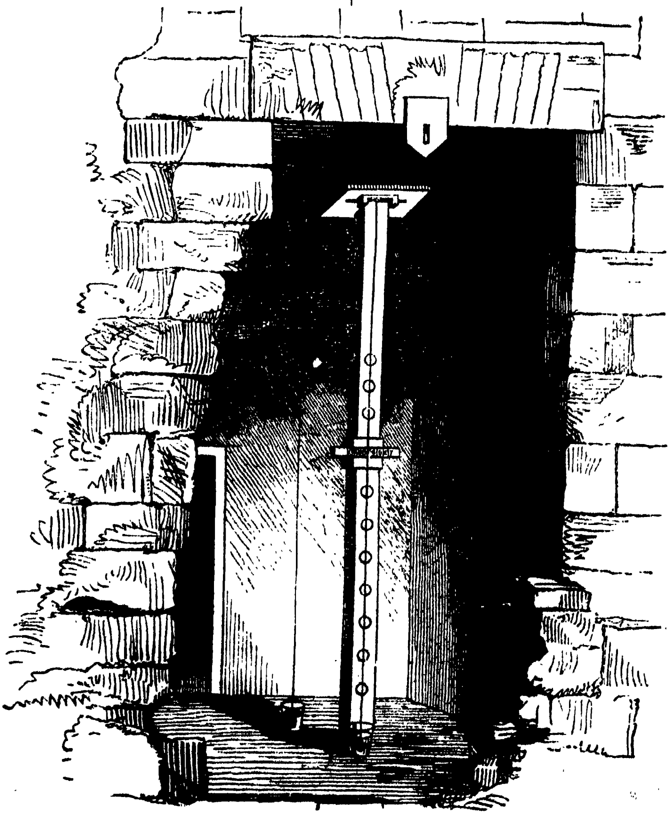


Fig. 2.

and light green tints on its outer and inner sides, particularly when the observers are so situated that the light falls towards their left or right hands. To vary this experiment, flowers cut out of white, light blue, and pink paper, will display the reflected and transmitted colours with great delicacy and pleasing variety, but the most beautiful results of all are those arising from the employment of a flower made in the same form as the others from a piece of burnished gold paper, the inside of which is *white*. Whilst the flower is rotating, it may be lightly touched with the finger, and instantly another combination of colours will take place, and on looking into the flower the colours will appear still more brilliant. These experiments with the black and gold flowers are, perhaps, the most interesting results that can be expected from the top, and which may introduce it into the *higher society* of scientific instruments, particularly if its modest name of *top* be changed to some fine-sounding Greek compound. It may then hold up its head, and spite of its giddiness, be noticed no longer as a mere toy but as a raveller and unraveller of the rays of light—a teacher of harmonies.—W. J. COOKE, *Darmstadt.*



Meridian Line.

A MERIDIAN LINE.—Mr. Noteworthy has been asked by several readers for some further particulars

of the meridian line described by his excellent friend Mr. Burder, of the Clifton Observatory, at page 353 of the first volume of RECREATIVE SCIENCE. Finding that nothing of a verbal kind could be added to the particulars detailed by Mr. Burder, he has obtained a drawing which, with the article referred to, will be sufficient to enable any amateur astronomer to construct so necessary and valuable an apparatus. In the cut a window is supposed to be taken out, and some masonry removed, in order to show the interior of a room as it would then appear to an observer outside.

MEMORANDA.—The electric printing telegraph of M. Dujardin, of Lille, is now exhibiting at Paris. It produces an entire Roman alphabet in seven seconds, eight alphabets in a minute, and writes and transmits a message of twenty-four words (about one hundred letters) in one minute. In place of wheels with heavy types, M. Dujardin employs a very light and slender aluminium wheel, on which are cut letters similar to those employed in marking linen.——Blue of Mulhausen is the name given to a new and beautiful dye obtained by MM. Schœffer and Gros-Renaud by the reaction of the red of aniline on an alkaline solution of gum-lac.——Turpentine as an anæsthetic has been employed by Mr. J. Wilmshurst. It is sprinkled on a handkerchief and applied to the nostrils. In cases of severe neuralgia, cramp, and slight surgical operations, it has been found to allay irritation, and cause a gentle sleep, from which the patients awake without headache, or any other unpleasant symptom. ——Mr. Robert Swinhoe, the British Consul at Amoy China, has written to the Zoological Society, stating that he is doing his utmost to procure for the gardens several Japanese and Formosan deer.

INDEX.

END OF THE THIRD VOLUME.

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[turn over.

BOTANY; acquisitions of foreign exploration, improvements in technology and classification, and the progress of inquiry into the genesis of plants.

CHEMISTRY, theoretical and applied, new discoveries, and results of theoretical and experimental research.

GEOLOGY, including Palæontology, Mineralogy, and Metallurgy; local examples of interesting groups of strata; formulæ for observers, and the relation of the facts of the science to other departments of knowledge.

METEOROLOGY, especially contributions towards the establishment of meteorological law; investigations of phenomena, and the influence of climate in the distribution of life on the globe.

MICROSCOPY; the numerous subjects for the especial elucidation of which the microscope is employed, will have a prominent place, and be largely illustrated, as will also the several points in the science of OPTICS, which bear on the construction and use of the microscope.

NATURAL HISTORY in the most extended meaning of the term, including ZOOLOGY and the adaptation of natural products to the uses of man in the arts of life and the furtherance of civilization.

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